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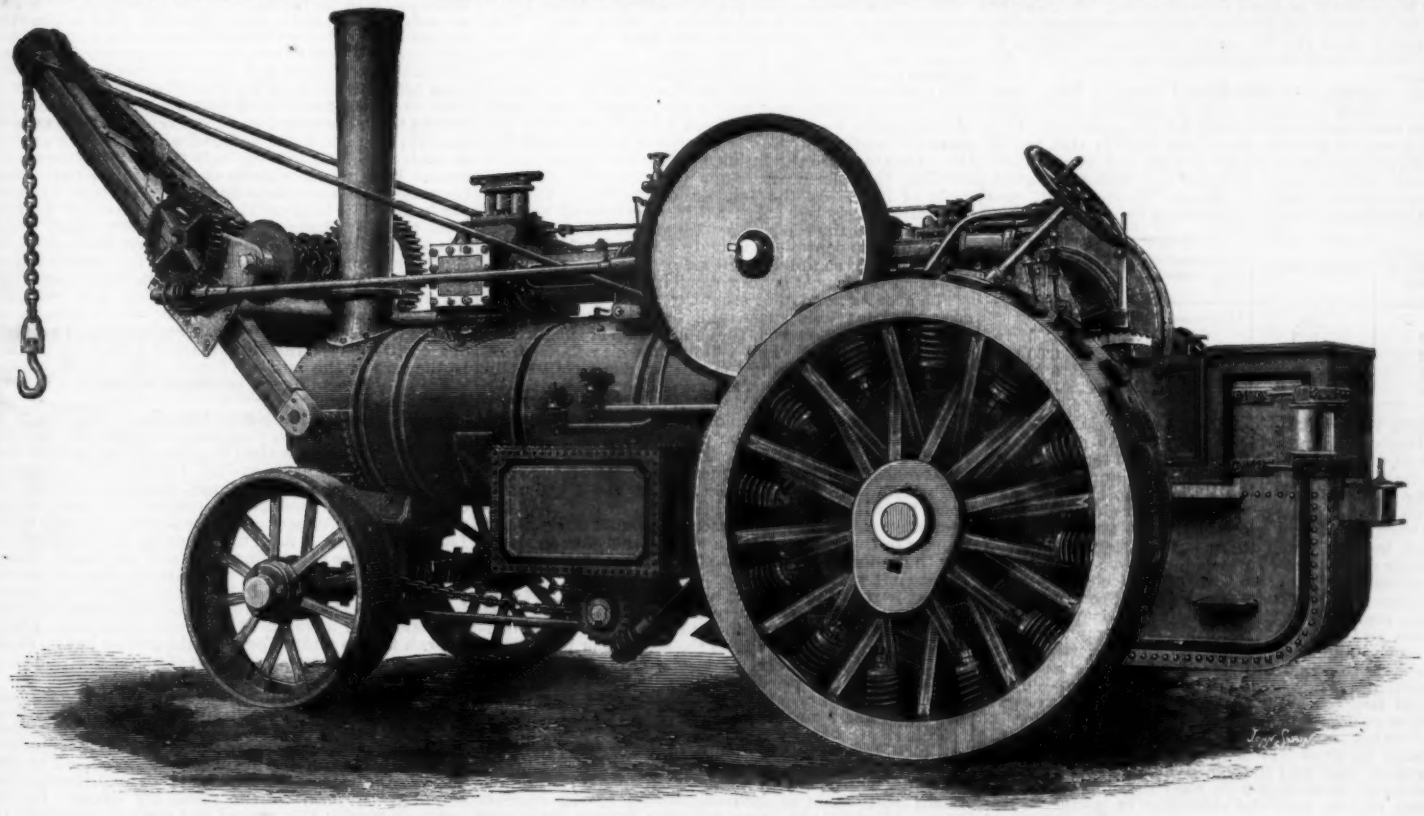
IMPROVED TRACTION ENGINE.

OUR engraving illustrates a new and very powerful form of engine by Messrs. MacLaren. It will be seen that it is a crane engine, and was made for a carting contractor in Liverpool for moving heavy marine boilers, lifting propellers out of barges, etc. Though it is only 12-horse power nominal, we believe, says the *Engineer*, it is probably the most powerful hauling engine extant. It is guaranteed to take 60 tons, and when tried a few weeks ago with a load of 48 tons it acquitted itself perfectly. The great power is obtained by the use of very slow gearing, the speeds being 1·04 miles per hour in slow speed and 1·9 miles per hour in fast speed, when the engine is running at 150 revolutions per minute. The engine has two cylinders, 8 in. diameter by 12 in. stroke each. The great adhesion is obtained by a new patent wheel, the construction of which will be readily understood from the engraving. The periphery of the wheel is fitted with loose biting pieces of cast iron instead of the usual diagonal cross pieces. These shoes, as they may be called, are cast in pairs, and are forced outward, each pair by one of Timmis' patent springs. The springs can be screwed down to any extent, and as there are always five biting or bearing pieces or shoes on the ground at one time, this has the effect of giving a great deal of adhesion to the wheel. In fact, much the same effect is obtained as with the India rubber wheel. The diameter of the driving wheels is 6 ft. 6 in., width 18 in., and the length of base, when the wheel is resting on the ground, is about 2 ft. The engine has been out about a month, and to test the springs, etc., Messrs. MacLaren ran it by road to Liverpool, and so far there has not been the slightest hitch in its working.



IMPROVED TRACTION ENGINE FOR HEAVY HAULAGE.

THE BLOWPIPE-FLAME FURNACE.*

By Mr. A. C. ENGERT.

THE importance of the question of the defects of steam boilers, as regards corrosion, pitting, and incrustation, has been very clearly demonstrated during the year which is now nearly closed, by the attention which engineers and men of science have given to the subject, and by the papers which have been read before the various scientific societies with respect thereto. The proposed remedies for these defects are far too numerous to be stated by the author, but he proposes to glance at some of the chief of them as given in papers read before various professional societies.

The first paper for notice is one which was read on February 27, 1884, before the Society of Arts, by Mr. Swinburn King, on "The Causes of Corrosion, Pitting, Incrustation, and Explosions of Steam Boilers." In this paper the author stated that the latter might be caused by the former. He gave some particulars respecting the committee appointed by the Admiralty, which sat from 1872 until 1880 to inquire into the causes of the decay of marine boilers, and which committee gave an elaborate report, but did not arrive at any satisfactory conclusion. Mr. William Weston, the chemist to the Admiralty at Portsmouth, a member of that committee, continued his researches, as some boilers had to be removed, owing to corrosion, after three or four years' service, at a cost of £50,000. This gentleman, after trying zinc plates, finally adopted the plan of attaching a zinc ball to the top of the boilers of the Royal Navy, the ball being connected by a copper wire to the sides and bottom. The invention is that of Mr. Hannay, of Glasgow, who found that certain parts of the boiler were exceedingly hot, and other parts were kept very cool by the blast of cold air. This produced a galvanic action, the great heat at the top of the furnace or firebox causing this part of the metal to differ entirely from the other parts, and to become negative, whereas colder parts become the positive pole and waste away. In other words, pitting and corrosion set in. To counteract this, a zinc ball was placed at the top in the boiler, and wires soldered to the side and bottom plates, and this reversed the action. The zinc ball becomes the positive pole, and wasting away and pitting cease as long as there is zinc and the connection holds good. This important preventive measure is now generally adopted and this view accepted by most scientific men. But this extraornary action is not the only result. Electricity is decomposing a small quantity of water in the boiler, the hydrogen of which is evolved from the negative pole, or the iron of the boiler; and wherever there is any settlement or scale, it is forced up from the plates whenever there is sufficient hydrogen accumulated, so that the danger of burning the plates is entirely avoided.

The next paper, on boilers, was read on March 3 before this society by the author, in which he described a newly-designed boiler having two flat flues with vertical tubes and great heating surface—thus preventing priming—short slanting firebars, no ashpit, and having a feed-water heater, to extract air and settle all solids of carbonates, etc., so that almost pure boiling water is pumped into the boiler, which was shown by independent reports to evaporate as much as 11·3 lb., and by another test 11·85 lb. of water per pound of coal. The water was raised from 81° Fahr., and the steam formed was as dry as if superheated, on account of the high steam space in the boiler. It had, moreover, only from 3 to 4 inches of water over the large flat flue, so that no convulsive force was required to penetrate a deep column of water for the steam formed over the plate to rise. The steam rises quite easily without forcing up water, which would cause priming. In this boiler the circulation is so great that no scale can be formed in the vertical tubes, only a little whitish mud being found on the top of the flat flue, and which is washed out by water. No unequal expansion exists, and as there is no ashpit the whole boiler is bricked in and produces no smoke. As no cold air can get into the furnaces, galvanic action cannot take place, as there is very little difference in temperature in this boiler, so that the plates are preserved and many dangers avoided. Since the author read that paper he has made a vertical boiler on the same principle, or rather two sections of a vertical boiler connected together by vertical tubes, and in the firebox of which the outside plate is bolted to the two sections, the firebox being lined inside with firebricks. This produces a rapid circulation of the water by reason of the vertical tubes and the large flat part of the top section of the boiler over the fire, which allows a large space for the steam. The author believes this is the first vertical boiler to produce thoroughly dry steam, there being only 4 or 5 inches of water over the firebox. On the back of the firebox there is a water heater to drive out the air and to settle the solids at the bottom, the heated water being forced into the boiler by an injector.

On April 3, at the Institute of Naval Architects, Mr. James Howden read a paper on the combustion of fuel in furnaces by natural draught and by supply of air under pressure. Mr. Howden stated that the trials were not quite complete, but he observed that forty years ago in Cornwall an evaporation power was obtained of 12·89 lb. of water per lb. of coal from 212° Fahr., but that now not more than 6 lb. of water could be evaporated from a Cornish boiler on account of the forced draught. He tried to prove that with a natural draught great economy was produced, as better combustion was the result. There was no surplus air to be warmed, and less heat was sent away to the chimney. He states that the fan blower has not been successful, except in locomotive boilers used in torpedo-boats, but that the marine boiler has been worked more successfully by the air-pressure in the stoke hold. Still it has a tendency to injure the boiler, as a column of cold air supplied at the rate of from 8 to 10 cubic feet per second must be detrimental, and he observes that Mr. Butler had stated that after several hours' trial many tube-plates became leaky. He then describes a marine boiler of his own in which the ashpit and every part of the boiler is well closed in, so that no cold air can enter anywhere except by pipes from a fan into the inclosure, in which the air gets warm, and is admitted partly into the ashpit and partly above the firebars. In this way Mr. Howden claims to have gained great results, but Mr. Parker, who had seen Mr. Howden's boiler at work, doubted if he could reach at once the 50 per cent. economy which he claimed. Mr. Wright, Mr. Bryce Douglas, and Mr. Marshall all questioned the anticipated result.

Before leaving Mr. Howden's paper, the author would quote the following statement from *Engineering*, for October 24, 1884: "Forced draught for marine boilers. Within the last few days there has been tested on board a steamer on the Clyde, and with unqualified success, the system of combustion in steam boilers patented by Mr. James Howden, as above described. The statements which were made by Mr. Howden in his paper are, however, we are informed, fully corroborated by the result. The New York City is a vessel of 1,754 tons gross, and was built at Stockton about five years ago.

* Paper read before the Society of Engineers, London, December 1, 1884.

She has recently been reboilered by Mr. Howden. Her original boilers were double ended, fitted with four furnaces, each 3 feet 5 inches diameter, and having an aggregate firegrate area of 75 square feet. Mr. Howden fitted the vessel with single-ended boilers, having only three furnaces, each 3 feet 4 inches diameter, and an aggregate firegrate area of 36 square feet. The results of the trial made on the Clyde, shortly stated, are as follows: The forced draught easily maintained, and higher pressure of steam than that produced in the natural draught boilers; the engine ran on an average of three revolutions more per minute. The consumption of coal was 9 cwt. per hour against an average at sea of 12½ cwt. for the natural draught boiler.

On August 6, at the meeting of the Institution of Mechanical Engineers held at Cardiff, a paper was read on the corrosion of marine boilers, by Mr. J. Henry Hallett. The author observed that steel boilers were equally liable to corrosion as iron ones. Serious corrosion was often found concealed by a very slight scale, which, upon removal, showed the plate to be covered with a black substance, probably a black oxide of iron. The principal causes of corrosion are twofold—defectiv design and mismanagement. The most frequent fault was stated to be want of space for thorough examination of the interior; the tubes were often placed too far out in the wings, and the manholes were too small. Double-ended boilers, the writer observed, were especially liable to suffer from racking strain due to the difference of temperature between the upper and lower parts, and he thought frequent pumping up and blowing partly down when the engine was standing kept his boilers in good order. New boilers, he said, ought to be well washed out before being filled, and when boilers were put out of work they should be blown out to the bottom and kept quite dry. Corrosion in the upper part of the boiler, Mr. Hallett said, was principally caused by the introduction of grease from the engine. He said he had discarded the use of lubricants in the cylinders, and had tried various methods of preventing corrosion, and found Hannay's electrogen very effective. He thought circulation of the water was of the greatest importance. That paper gave rise to an important discussion, in which air in water was mentioned as being very destructive.

Many experiments with forced draught have been made, and that system is now in practice, and many articles have been written both for and against it. One thing, however, is quite clear, and that is that forced draught causes a great waste of fuel, and is no doubt very destructive to some parts of the boiler so forced. A torpedo-boat, built by Messrs. Thorneycroft, was tried in January, 1880, the following being the results:

Air Pressure in Inches of Water.	Coal per Hour.	Temperature in Funnel.	Lb. of Water evaporated per lb. of Coal.
	Lb.	Degrees Fahr.	
2	925	1,073	7·06
3	1,177	1,192	6·60
4	1,472	1,260	6·33
6	1,815	1,444	5·97

Messrs. Yarrow & Co. conducted some trials with torpedo-boats in January last. Burning 15 cwt. of coal per hour, they found that the resistance to air pressure was 1 inch in passing through the fuel, and 3¾ inches in passing through the tubes. The heat in the funnel and the great amount of smoke with its invisible gases alone would show the enormous waste going on in the furnace, besides which there is the wear and tear of the boiler and tubes. In locomotives a great waste is also going on. From 60 to 100 lb. of coal are burnt per square foot of firebars per hour, and complete combustion, especially in the marine boiler, is quite out of question, as there is no time for the proper development of the flame and heat. Much less is there time for the heat to penetrate the metal for the formation of steam; and if means could be found to produce the required heat without the forced draught, the gain would be very great.

The author having brought before the members the substance of what has been written and said during the present year, and having given the different views expressed in connection with the subject of the defects of steam boilers, and the difficulty in 'getting out of coal in the steam boiler furnace the whole of the work contained in it, he will now explain the principle of his new furnace, which from its action he has named the blowpipe-flame furnace. In designing this furnace, economy in fuel and the preservation of the boiler have been his chief objects. Fig. 1 of the illustration (next page) shows a front view of the boiler, half in section and half in elevation, while Fig. 2 is a part longitudinal section. From the engravings it will be seen that the furnace has sloping firebars, on the back of which is built a raised firebrick embankment some 3 feet 6 inches long; behind this is a dust pocket about 3 feet long, and then comes the ordinary bridge. In the front of the furnace is a shallow cast-iron box in which hangs a cast-iron plate reaching down to about 1 inch from the bottom of the box. The plate has at its lower end a few rows of holes or slots, and it may be raised altogether when firing is required. In front of the box are doors leaving also an inch opening at the bottom.

Combustion in nature may be favorable or unfavorable. In both cases there are degrees, and it is necessary therefore to find out the most favorable conditions for producing the most complete combustion, and to obtain the highest degree of heat with the smallest amount of waste in fuel. A fire lighted anywhere will produce a draught; but if a few stones are placed so as to form a back to the fire, then the draught will be stronger, and at certain points greater heat will be manifest. If a passage is then formed under the fire for a short distance, and a few more stones are placed in front and connected with those at the back, a foot or two high, a furnace is formed complete. The air can only enter at the bottom, and the heat evolved is confined to a certain space, which can then be led to wherever required without any diminution, except a little radiation, always supposing that no air is allowed to enter between the stones forming the furnace. Such entry would, of course, naturally diminish the heat, as part of the heat which had at first been formed must go over to the cold air. Besides, the various gases are condensed, and form smoke. This being a very important point, care ought always to be taken that the bottom or grate is well covered with fuel, so that no air can enter without coming in contact with the burning or incandescent mass, in order that every particle of oxygen may at once chemically combine with a certain volume of carbon and hydrogen gases to form heat; and as it is well known that nature is very economical the engineer ought to imitate her, and see that no waste of air or fuel be allowed to go on in the furnace. The proportionate volumes of gases necessary for complete combustion are so well known that it is unnecessary to mention them here, but a comparison may be made with the ordinary furnace in use. In France, where the fire-grate surface is in general considerably larger than in this country, the fuel is very thinly and sparingly spread over the bars, so that large volumes of air are allowed to enter the furnace without coming in contact with the gases of the fuel. Now, what does this produce? Suppose certain volumes of gases create, by chemically combining, a heat of say 3,000° Fahr. If other volumes of cold gases enter which create no heat, then the former must give up some of their heat to the latter. Here, then, is a point which must be closely examined. If every particle of oxygen could be made use of, then 75 cubic feet, or 11 lb. of atmospheric air, would suffice to burn 1 lb. of coal. But instead of this, our ordinary furnaces being so badly constructed, it is calculated that 150 cubic feet of atmospheric air is necessary for the complete combustion of every pound of coal, and the consequence is that only a very small part of the gases enter into complete combustion, and even these are soon robbed of their heat by the other cold gases coming in contact with them. Still this 150 cubic feet of atmospheric air is only a moderate quantity per pound of coal. Very often 200 cubic feet and more enter the furnace per pound of coal, and with a few more than 400 cubic feet of air per pound of coal is driven through the furnace as in a torpedo-boat. There certainly may be some 3,000° Fahr. in the furnace and some 1,400° Fahr. in the funnel, but at what waste of fuel, and at what destruction of material and power is this accomplished!

Out of the uptake pours one continual dense black smoke, and at night a red flame is often seen. This black smoke may perhaps be the least loss, the condensed invisible gases formed being much greater in amount; in fact, only a small quantity of fuel forced into the furnace is properly consumed, which is proved by the small quantity of water evaporated per pound of coal, which is at the best from 5 to 6 lb. of water per pound of coal. The ordinary furnace is not much better. Looking into the furnace door where green coal is burning, the color of the flame will show the development of heat. At the bottom of the flame there is generally a dirty red color, a little higher red, orange, and at last on the top a yellowish white. This latter is well known to contain the greatest amount of heat, but the amount of complete combustion entering the chimney as carbonic acid is very small in comparison.

The greater portion of escaping gases are oxides or condensed invisible gases, and form smoke. On the whole this will show that the combustion in the furnace is very incomplete. The yellowish white flame from bituminous coal is giving the highest degree of heat in the ordinary furnace, but it is well known that it is by no means the greatest heat which can be obtained. By the help of the blowpipe, blowing into a burning coal, a transparent flame may be produced with a tint of bluish or greenish color. This flame gives a much greater heat, and it may frequently be seen arising from anthracite coal or good coke. But the flame from these fuels is very short, and the heat, therefore, concentrated within a small space, which is a source of danger to the boiler plates; and it is, therefore, no wonder that engineers, fearing to burn holes in their boilers, do not want any greater heat, forgetting that the largest part of the steam in a boiler is formed just over the bridge, and that on these few feet of plate the most and the hardest crust is formed from the solids contained in the water of which the steam has been formed. This concentration of heat ought, therefore, to be avoided at any price; but by distributing the heat over a much larger surface of the plates it penetrates to the water and forms steam.

This result has been successfully obtained by the author's new furnace with a firebrick embankment and bridge, and which has the firebars sloping downward to the front, with a proper guide for the air beneath the firebars, as shown in section in the engravings. A guide to the draught will help it to flow easy by a gentle sloping course from under the firebars for the better combustion of the fuel. It is of the utmost importance that all corners and obstacles should be avoided for the proper guidance of draught for the fuel to the top of the firebars. These firebars have been made to slope downward to the front, so that the air, entering in front at the bottom of the door, and guided by the slotted plate hanging down within, acts on the burning fuel similarly to the blowpipe, and produces a long, bright transparent flame with a tint of blue or greenish color, which shows that thorough combustion is going on. In this furnace no atom of oxygen from below or from the front can escape without coming in contact with the fuel and thus producing almost perfect combustion. The damper is generally one-third open, but this is quite enough for the burning mass to draw in the atmosphere by its own gravity, and therefore not a particle of air is drawn in more than is actually consumed by the fuel, so that the heat once formed by the gases within the furnace is retained, and not reduced by a useless and damaging surplus of cold air.

The slanting firebars have another very important purpose, and that is, to guide the bright flame as near as possible to the boiler plates, and to keep it near the plates the firebrick embankment is formed about three feet six inches long, conforming to the shape of the boiler, and leaving only an eight inch space at the front end, and a seven inch space at the back end between them. At the end of this embankment is a pocket or chamber for any heavy dust that may have been brought forward by the draught to settle in. Then comes the so-called bridge with a seven inch space between it and the boiler, so that the flame, some ten or twelve feet long, is obliged to remain the whole length close to the boiler plates. Thus the area of heat penetrating the metal to form steam is at least four or five times greater than in an ordinary Cornish or Lancashire boiler.

It should be remarked that the air entering the furnace from the front at the bottom of the hanging plate is only the small quantity necessary for supply to the gases rising from the top of the fuel, chiefly after firing when the coals get warm, which opens the pores and allows the compressed volatile gases to escape in large quantities to the amount of some 17 per cent. of their weight. These gases seldom find the oxygen required for their combustion within the furnace, as the air which enters through the firebars, and the incandescent fire, has for the most part combined with the volume of oxygen or hydrogen to form combustion. It will therefore be seen that a further supply of air is necessary for these newly liberated gases to enter into combustion. Warm air and a forced combination of the gases, as in the present instance, of course produces the highest degree of combustion. The author would, however, caution steam users against allowing the air to enter from the front at the top of the furnace, as such air would absorb a great deal of heat, and would mostly float on the top of the burning gases, being raised by the superheated moisture which the atmosphere contains, and forming a thin layer close to the boiler plates. Thus to some extent the heat would be prevented from penetrating the plate and reaching the water within the boiler.

And here the author may explain why it is that when the fire-door is ajar very little smoke is visible, and that if the stoker endeavors to prevent smoke, he leaves the fire-door ajar, not knowing either the mischief or the cause and effect of what he is doing. The matter, however, is simple enough. The atmosphere requires to exert more force to get through the bars and fire upon them, and it therefore enters more easily at the front door and produces the entry of air from below. The quantity being very small, and no condensation taking place, little or no smoke is formed.

The principle of combustion in a furnace or the combination of the gases is easy of explanation. The oxygen leaves its companion nitrogen and flies quickly to its more attractive friend carbon or hydrogen. Still it has been proved that when some force is used to bring the two gases together a more complete combustion takes place, as for instance by the blowpipe, by which a much greater heat is then obtained. This is what the author tries to do by the blowholes in the iron plate; at any rate he is able to obtain a much greater heat than any ordinary furnace has ever produced. A Lancashire boiler 18 feet long by 7 feet diameter has generally from 30 to 36 square feet of firebars, but by the author's system there are only 7 sq. ft. of firebars, which are 3 ft. 6 inches long and 2 feet wide, of which 2 inches are lost on each end, thus leaving only 6 feet 4 inches square clear. With this small area of firegrate the author has been able to evaporate as much as 178 gallons of water per hour. The heat on the firebars has often been so great that they have melted, and a few small steam jets have been placed beneath the bars to cool them. It appears that the air guide under the bars compels the atmosphere to ascend through the bars, there combining with the gases, the whole being met from the front by a supply of fresh oxygen, which greatly increases the heat, just as two gas jets meeting at a certain angle will increase the illuminating power and flame. In the case of the author's furnace, besides increasing the heat the confluence produces an extraordinarily long transparent flame.

It may here be mentioned that when firing the mass of fuel is pushed back, and fresh coals are fed into the furnace. The heat is then so great in the furnace that hardly any red flame is visible, and hardly a vapor of smoke passes from the chimney, the damper being left open. The coal used is the commonest hard steam, costing about 13s. per ton. The boiler, although of the Lancashire type, is fired underneath, having been set for the purpose of burning chips and sawdust. But if this boiler was fired in the two flues, the firebars in each flue would only require to be two or three feet square in area, with the embankment and the bridge as shown in section. If a couple of Galloway tubes were placed in each flue to retard the heat, the author has no doubt that a much larger evaporation of water per pound of coal could be obtained with the greatest ease.

Of the many tests made, the water being measured and coal carefully weighed, the author here gives some showing the difference of draught, water evaporated, and coal used, and the area of firebars with a movable dead plate on the top ,front of the bars. The first test experiment was to ascertain the smallest grate area required to produce the necessary steam for the author's works; the second was made to ascertain the maximum quantity of coal to be burned per square foot per hour, while the third was ordinary firing.

No. 1. September 2, 1884. Test time, 4 hours, with damper about one-third open, and 4 feet 1 inch square of firebars, beginning with 40 lb. steam pressure, but losing during the four hours 25 lb. pressure, burning 3½ cwt. of coal, and evaporating 492 gallons or water, or 123 gallons with 98 lb. of water per hour, equal to 12½ lb. of water per pound of coal.

No. 2. September 8, 1884. Time, 3½ hours; 6 feet 8 inches square of firebars, damper full open, 49 lb. steam pressure, and blowing off all the time by a 1-inch steam pipe from the boiler, besides using steam for factory use, firing about every half hour, with 1 cwt. of coal, 7 cwt. in all used, evaporating 605 gallons of water, or 173 gallons with 2 cwt. of coal per hour, or nearly 7¾ lb. of water evaporated per lb. of coal. In the first hour the coal consumed per square foot of firebars was 41 lb., but afterward the bars got foul and the average was 33½ lb. of coal per square foot of firebars.

No. 3. September 29. Time, 4 hours; test made with 4 feet 8 inches square of firebars, damper not quite half open, steam pressure 45 lb., afterward went up to 50 lb., steam blowing off and evaporating 451 gallons of water, burning 3 cwt of coal or 112¾ gallons of water, with 84 lb. of coal per hour, giving 13⅜ lb. of water per lb. of coal. It should be remarked that the boiler has not very high steam space, and will prime a little when worked at a high pressure.

The first and second trials afford a striking illustration of the waste going on with a forced draught. In the first instance the damper was only about one-third open, and the heat produced must have been as great from the small quantity of coal supplied as from the larger quantity of coals forced into the furnace with the damper quite open, and a stronger draught. If the latter had produced a greater heat, then a larger quantity of water ought to have been evaporated per pound of coal; and it stands to reason that in the first instance the flame had more time to perfectly develop itself. Another important point is that there was time for the heat to penetrate the metal for forming steam,

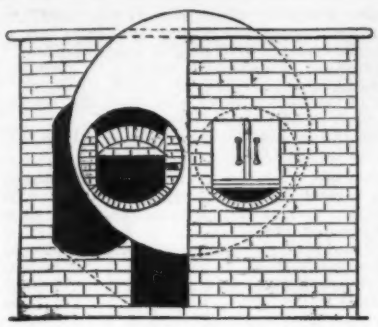


FIG. 1.

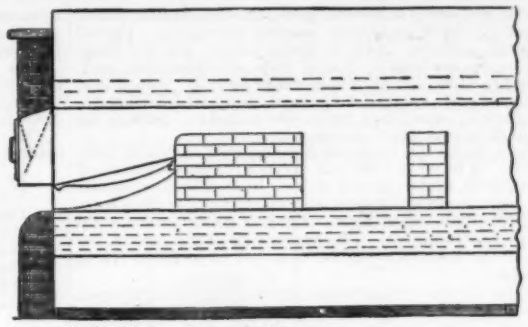


FIG. 2.

THE BLOWPIPE FLAME FURNACE.

the quantity of which must have been considerable, while in the second trial more than double the quantity of fuel evaporated only 40 per cent. more water, therefore 37 per cent. of the entire supply of coal must have been lost, or the heat produced by it carried away into the chimney. This furnace proves that it is not that a great quantity of solid or gaseous fuel is requisite to produce a high degree of heat, but that it depends entirely upon the proportion or volume of gases and the guidance of such gases, which produce a force tending to the perfect combination of the gases. . . .

The author thinks there can be no more striking proof of the correctness of this theory than the fact that the flame produced in his furnace,and the heat arising therefrom, do their full work, leaving only a minimum of heat behind. It is of course a natural result that the more complete the combustion of fuel, so much greater the heat of the flame must be; and it stands to reason that the greater heat will more easily penetrate the metal, and be absorbed by the water within. This will go on until all the flame is so absorbed as to leave very little unconsumed gases behind except some condensed vapor. This is proved in the long flue toward the chimney, where the heat has generally been from 290° to 300° Fahr., in all other tests or trials. But in the author's furnace there is no more than 200° Fahr. of heat at 1 foot from the damper, and one-half degree less at 20 feet distant from the damper in the flue.

Two tests have been made with this furnace by independent engineers, one by Mr. D. K. Clark, and the other Mr. W. Schonheyder. Mr. Clark's test was made on November 10, 1884, and the following are the leading results as stated in that gentleman's report to the author:

Results of Test.

Temperature of atmosphere	54° Fahr.
Weather	N. W. breeze. Fair.
Duration of test	6 hours 50 minutes.
Coal consumed	721·5 lb.
Coal consumed per hour,	105·6 lb.
Coal consumed per sq. foot of firegrate	21·86 lb.
Number of firings	14
Average interval between firings	29·3 minutes.
Weight of fuel per firing,	51·5 lb.
Clinker produced	14·5 lb.
Ash produced	25·0 lb.
Clinker and ash residue	39·5 lb.
Clinker and ash per cent. of coal consumed	5·47 per cent.
Average pressure maintained in boiler per square inch	34·0 lb.
Temperature of burnt gases in flue to the chimney	200° Fahr.
Average temperature of feed water	70° Fahr.
Quantity of water consumed	150·8 cubic feet.
Quantity of water consumed per hour	22·08 cubic feet.
Quantity of water consumed per square foot of firegrate	4·57 cubic feet.
Quantity of water consumed per lb. of coal consumed	13·02 lb.
Quantity of water consumed per lb. from and at 212° Fahr	15·11 lb.
Quantity of water consumed per lb. of combustible	13·78 lb.
Quantity of water consumed per lb. from and at 212° Fahr	15·98 lb.

Mr. Clark states that the steam proved to be dry, and there was no evidence of priming in any way. The broad result here is an evaporation of 13·02 lb. of water per pound of coal from a temperature of 70° Fahr. The test was made under conditions of slow combustion, only a small proportion of steam being used during this trial for driving the machinery in the author's works, most of the hands being absent on a holiday.

Mr. Schonheyder's test was made on November 20, 1884, and the following are the tabulated results given in the report made by that gentleman to the author:

Results of Test.

Length of test	8 hours 25 minutes.
Water withdrawn from tank	12,857 lb.
Water withdrawn from tank per hour	1,531 lb.
Coal thrown into furnace,	1,120 lb.
Coal thrown into furnace per hour	133 lb.
Mean temperature of feed water	74° Fahr.
Mean pressure of steam (27 lb. to 40 lb.)	35 lb. per sq. inch.
Mean temperature in back flue (348° to 376°)	350° Fahr.
Mean temperature of atmosphere	44° Fahr.
Water per square foot of heating surface per hour	2·66 lb.
Coal per square foot of grate per hour	29·6 lb.

The evaporation would therefore appear to have been at the rate of $\frac{12857}{1120}$ = 11·48 lb. of water per pound of coal from 74° and at 35 lb. boiler pressure.

The equivalent evaporation from and at 212° would be 13·39 lb. of water per pound of coal.

At the conclusion of the test 40 lb. of ashes and clinkers were left, equal to barely 4 per cent. of the coal used; 13 lb. of cinders were also left, but evidently of small value.

In his opening remarks the author showed, on the authority of careful scientific investigators, that pitting and corrosion were due to the action of cold air impinging on the boiler plates. As in the author's furnace cold air is carefully excluded from direct contact with the boiler, it follows that, the cause being absent, the effect is obviated, and that therefore pitting and corrosion cannot occur in bodies properly set and fired upon the blowpipe-flame system.

In conclusion, the author would simply state a well known fact with regard to the burning of ordinary coal gas which will serve to make the matter clear to any one who may be in doubt as to how such high results are obtained in the author's furnace as compared with ordinary systems. Five cubic feet of gas burned in an ordinary gas burner gives out a known and definite quantity of heat. Five cubic feet of gas burned in a Bunsen burner, in contact with a definite and properly regulated quantity of atmospheric air, develops a far greater proportion of heat. In like manner a pound of coal burned in the ordinary way will give out a certain amount of heat, but a pound of coal burned with the assistance of the blowpipe develops a great excess of heat. This simple statement needs no comment from the author. It forms the keynote to the successful results of the furnace he now has the honor to bring under the notice of the society.

STEAM CATAMARAN.

THE boat consists of two pontoons, each 2′ x 30′ and 1′ 8″ deep placed 4′ apart. Beams 2′ from centers connect rigidly the pontoons; on these is laid a floor of ¾″ matched boards. These beams are secured by ⅜″ bolts 25′ long extending from bottom of boats to top of deck beams. The pontoons are covered water tight, and each divided into two tight compartments. The upper works are formed by stanchions with carline beams, on which is the upper deck of ⅝″ timber. The pilot house is well up, so wheelsman can see fore and aft. An opportunity is also provided for stearing in cabin, which is inclosed with canvas curtains, secured to stanchions, as are carriage curtains, only stronger. In the cabin extra stanchions are set up when wanted to support folding cots, all of which takes but little room, by day, when not wanted.

The boats are nearly straight on inside lines, gathering enough water, as I find on trial, so that, with the draught back, caused by the wheel, the water remains same height between the boats, when running, as outside, This is my second experiment in steam catamarans, and I am convinced it is the best plan for steam yachts up to 60′ and perhaps longer, for the following reasons:

1. It is not cranky—"stiff as an island" they say—half a dozen men on one side scarcely change the level even of this small boat.
2. Safety from sinking—the four air-tight compartments must all be filled before it will go down.
3. Cleanliness—all ashes and cinders go direct from the fire box to the water below.
4. Speed—nine miles an hour in still water.
5. Protection of boats from weather—the floor forming a sun shade.
6. Roomy—place for six to sleep in cabin; ice box, lockers, oil stove box, and coal bunker forward, and all accessible.

The power is a 4 x 6 engine and upright steel boiler with seventy 1½″ flues 24″ long submerged. I think that with 120 pounds boiler pressure I obtain about 260 revolutions, which gives about 5 horse power. The engine is faulty in construction in that the exhaust is but two ¾″ pipes from either side of steam chest, the area of both but little more than one 1″ pipe. With 60′ of heating surface, more steam could be made, with poor wood, than the engine would use.

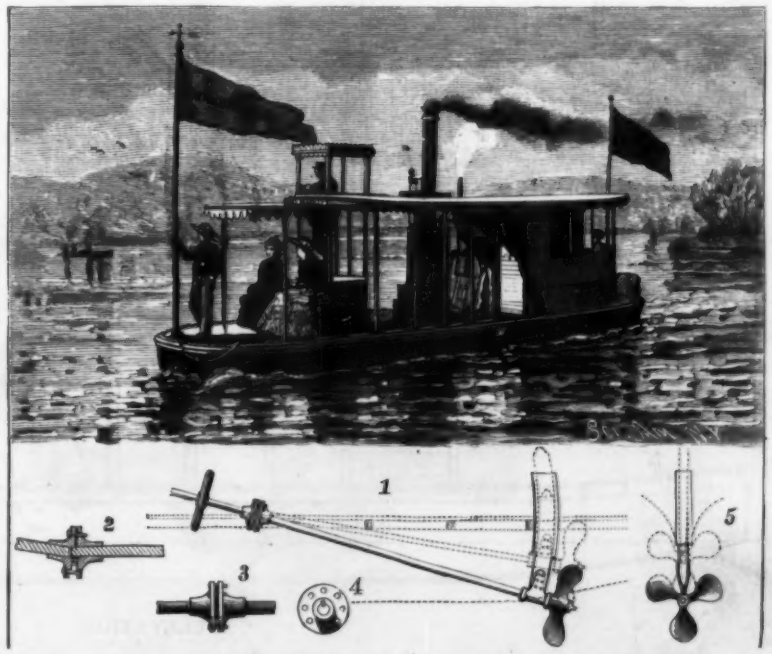
The boiler is all above the furnace. The grate is hung in center, and dumps into the water between the boats. My plan for feeding boiler I think is novel. From the deck pump the water is all forced through the feed pump, thus facilitating "starting" the feed pump, making it almost a certainty. When at dock with steam up, the waste of water is very easily supplied by hand, and more surely than with any small inspirator I have seen. By a simple device the leverage is changed when pumping by hand against a head of steam. The feed pipe coils around fire, and only hot water enters boiler. The inlet is in center of lowest point in boiler, taking place of one tube. An outside vertical circulating pipe secures good circulation.

The wheel is 3 bladed, 24″, and is arranged to be raised in shallow water, being attached to main shaft by universal joint, which is shown in Figs. 1, 2, 3, 4, and 5. The flange faces are 7″, turned to segment of sphere, with length of propeller shaft as radius. Eight steel pins, ⅝″ diameter, 3″ long, are riveted into the flange attached to engine shaft, and work in holes reamed tapering in flange attached to wheel shaft. Wheel shaft extends into flange on engine shaft, about ¾″, thereby helping to keep wheel flange in place. The wheel shaft is hung in bearing secured by a steel plate bent around and riveted to lower end of a piece of oak 2½″ by 4½″, tapered like a wedge at lower end, curved with length of wheel shaft as radius, and sliding vertically in a similarly curved casing securely bolted to deck beams. The wheel blades, when at highest point, just clear deck, and are not submerged entirely. Engine shaft is inclined so as to bring wheel shaft in line when in ordinary use, *i. e.*, down. This pitching wheel shaft has not proved objectionable, thus corroborating the views of that party who urged the inclined shaft so strongly before one of your New York societies two or three years since. By the way, does this universal joint coupling happen to be new? I never saw it. I know it is good.

For cruising I have never seen a more comfortable rig. A party of seven last summer were out weeks with it, and were certainly very comfortable. With a mosquito net around the cabin, and when hot with the curtains down a little, the nights were delightful.—*Wm. B. Reed, Sci. Amer., Nov.* 1, 1884.

STEAM CATAMARAN MAY BARRETT.

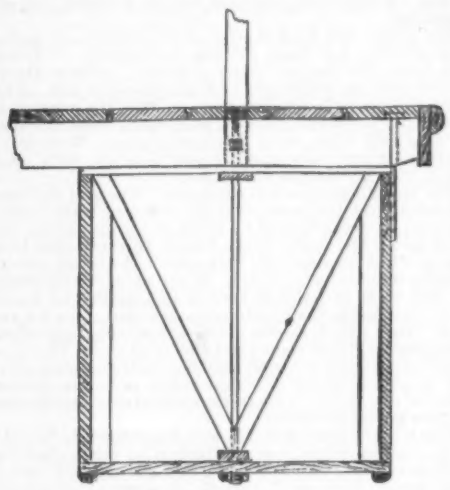
THIS craft was a second experiment in steam catamarans by Wm. B. Reed, of Hastings, Minnesota, built in spring of 1883, for a family cruising boat, to use on the rivers and lakes in that vicinity. Its construction was made a pastime by its builder when prevented from active business by ill health. A short description and cut of the boat was published in the SCIENTIFIC AMERICAN of Nov. 1, 1884, which created so much interest and brought to Mr. Reed so many letters of inquiry for further details that, at our suggestion, the following additional plans and specifications have been furnished



THE STEAM CATAMARAN MAY BARRETT.

by him. For further information, address Mr. Reed as above, and he asks that those building steam catamarans will advise him of the results of their experiments.

Construction of Hulls.—No regular frames were used, in building the pontoons. Sides of ⅜″ pine, 24′x30′. As so large boards cannot readily be had, use ⅜″x1¼″ strips, and with tenpenny casing nails fasten one on another to build up the sides. Timbers or ribs 1¼″x2″ of hard wood 4 ft. apart will sufficiently support these sides. (*Note.*—On the May Barrett, no timbers were used, as she was not so deep. From the past season's experience, I think greater depth will be an improvement, and so modify the plans, but only in this particular, and the consequent greater inclination of engine and wheel shaft.) Bottom is of ¾″ matched stuff, with shallow tongues and grooves, nailed on crosswise. Decks ½″ matched, also placed crosswise. Inside the hulls are 1″x3″ hard wood keelson strips, thus



CROSS SECTION THROUGH HULL.

forming a third nailing for bottom boards. A similar strip, only smaller, under decks in center. Braces, say 1″x1½″, 2′ from centers, meet at center on keelson on either side of the ⅜″ rods, thus enabling the nuts to be screwed down tightly, and rigidly holding deck beams in place. Two 1″ half round oak sand strips and a wider similar piece are well fastened to outside on bottom of hulls. The center one of these receives the flat heads of the bolts. About midships are bulkheads dividing each hull into two air-tight compartments. I used a little pitch in joints as cheaper than nice workmanship. Four holes with 3″ tubes, extending from deck of pontoons up through main deck, enable them to be pumped out, though the May Barrett did not leak. Some device must be used to keep the inside lines of the pontoons from curving. For this purpose, with screws, I attached a 2″x10′ 18′ long edgewise to inside boards till the bottom was nailed on. Of course, after the pontoons are connected with the deck beams, all is secure. The decks of the pontoons should be well painted before deck beams are put in place.

Deck Beams.—Of Norway pine, or some similar wood, 1¾″x3½″. If of good oak, smaller would do. Placed 24″ from centers. Nine of these beams are 8′4″ long. The beams are held by the ⅜″ rods, and also along midships are straps in addition, made from ⅛″ round iron flattened and punched for screws, with which they are attached to outsides of hulls—the round end passing up through beams with nuts on top.

Main Deck.—Of matched flooring well nailed to deck beams. A band of 1″x4″ oak extends continuous around entire deck, nailed to end of deck beams, being steamed and bent to place forward and aft, the upper edge coming flush with top of deck. A 2′ half round fender strip completes the finish. The under side of the beams, between the hulls, should be boarded over for obvious reasons.

Upper Works.—Stanchions about 1¾″ square, tapered, placed 24″ from centers, extend down through deck, and are bolted to sides of deck beams, and are further supported by malleable iron braces on deck. Carline beams are of hard wood ¾″x2¼″, on which the upper, or hurricane, deck is laid of say ⅛″ boards, covered with drilling, and painted with yellow ocher and oil. The finish of the upper works is shown in cut, and of course can be made more elaborate or less so. I had the advantage of good wood and also iron working machinery, and so saved much labor. The rudder stem extended up to upper deck, and had a segment of a circle of hard wood attached to upper end with grooved edge, in which worked wire wheel ropes, running under upper deck forward to wheel. The curtains inclosing cabin were of 8 oz. duck with brass grommets in same about 12″ apart, which button on to brass screws in stanchions. Curtains were made as much as possible interchangeable and entirely detachable. The cabin was carpeted, and fitted with lockers, etc. On a cushioned seat across the cabin aft were conveniences which were quite unobservable to those not posted. A curtain, when needed, shut off this portion as a dressing room, etc. It would take too much space to describe the two-story folding cots, which made comfortable beds for six in this cabin, and which, when set up for day use, made two comfortable lounges. Will only say the feet of the cots extended into mortises in the side of stanchions instead of resting on the floor. The canvas of the awning forward is removable in case of heavy wind. Under the pilot house floor is a fuel bunker. Forward of pilot house is an ice box, water tank, and grub box 2′ 6″x1′ 8″x2′ 4″, which is a veritable *multum in parvo*, and which the artist has supplanted with the two nice girls, thus evincing the bent of his taste. The girls were there, however, but they sat on the box.

Engine and Boiler.—Almost any engine and boiler is available in such a boat. What I used was made to order, but could be improved upon, so I need not describe it more in detail. The weight was more than needed; some 1,500 lb. for machinery and outfit, which was about half the entire weight of complete boat. I think two of Shipman's No. 2 kerosene burning steam boilers and engines with two 14″ wheels would make a nice power for catamarans of this size. Their first cost would be less than the power I employed, and also less expensive for fuel, besides rendering the draught less, which is quite an object in most waters. I know nothing personally, of the practical working or durability of these engines, however.

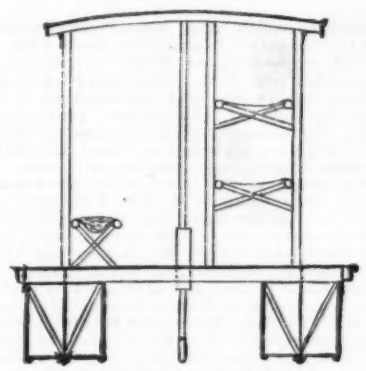
Wheel.—The propeller I used is not as shown in the cut. It is of my own construction. A brass hub has three steel blades bolted to it in shape almost like the clute wheel, Fig. It was 24″ in diameter, and of such a varying pitch and peculiar twist that I could not measure it. Probably about 36″. It was very strong, and has often stopped the engine dead from full speed by coming in contact with rock or other obstacle.

The pitching wheel-shaft seemed to prevent the stern sinking, as in common in small steamers. The tendency of the boat was to rise, and she seemed to draw no more at full speed than at rest.

The cost of the May Barrett was about as follows, exclusive of my own labor:

Lumber bill	$50.00
Nails, screws, etc	8.00
Paint	10.00
Duck, carpet, etc	12.00
Boiler and fittings	200.00
Engine and fitting	125.00
Wheel and shaft	15.00
Sundries	15.00
	$435.00.

In building a catamaran, parties must consider that



CROSS SECTION.

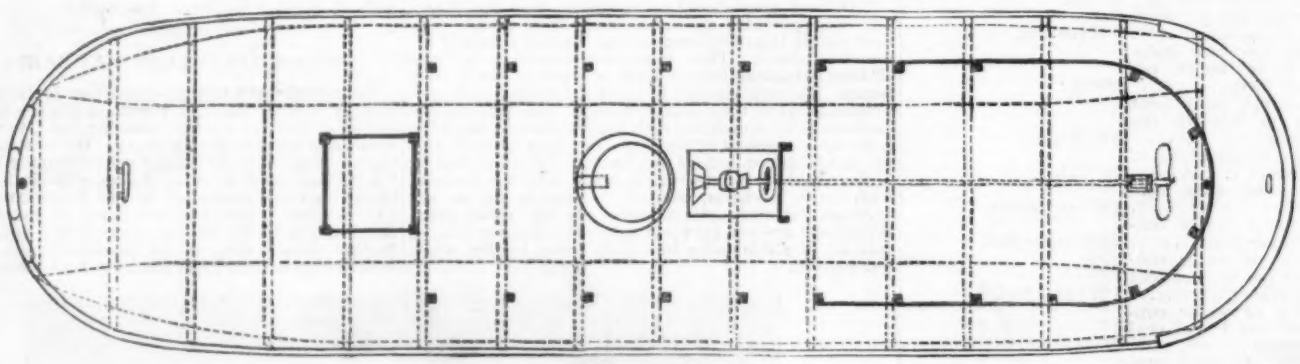
the displacement is the measure of carrying capacity, as in other boats, and that they are deceiving in this direction. The Mary Barrett proved a better sea boat than was expected, riding a moderate sea quite shiplike.

WM. B. REED.

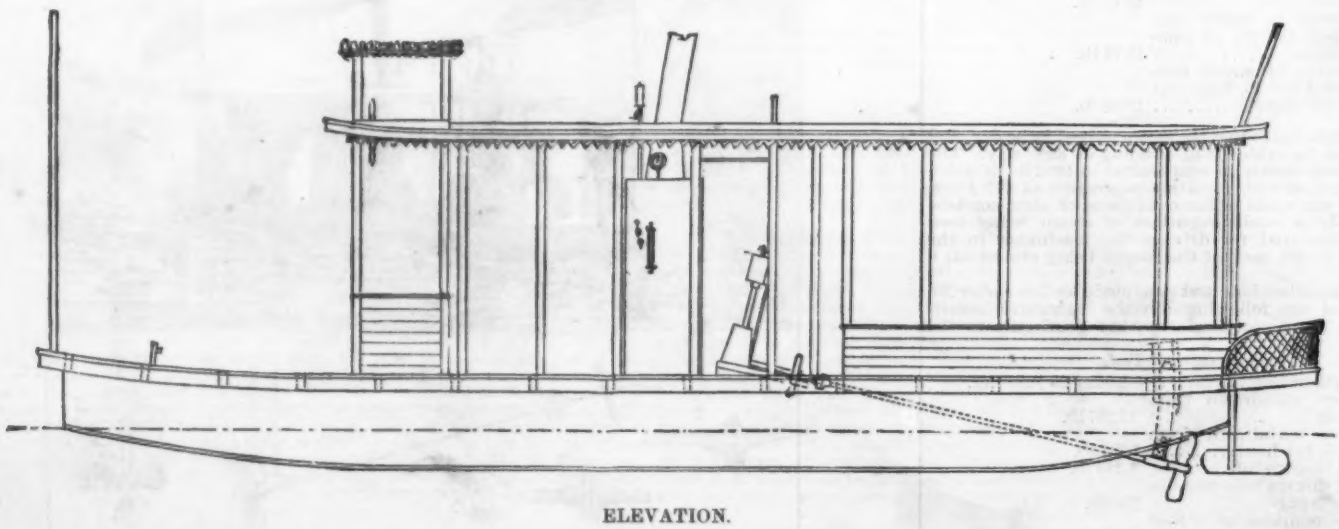
THE STEAM ENGINE INDICATOR.

By AMICE.

KRAFT'S indicator, to which we referred in our impression of Dec. 6th, is illustrated by the accompanying perspective and sectional engravings. This was one of the first indicators made with a very light pencil arm having a free end. The other moving parts were also reduced to the smallest weight. In our engravings (Fig. 1), *a* is the steam cylinder, fitted with a piston, *b*, the piston being, as is usual in these instruments, made steam tight by a very accurate fit, the cylinder being very carefully bored. No rings or means of making the piston tight, except accuracy of workmanship, are ever used for indicator pistons. The upper part of the cylinder is slightly enlarged and closed by the cover, *c*, while the lower part is firmly screwed into the tapered end piece, *d*, which fits into the upper part of the indicator cock at *e*, where it is held



DECK PLAN.



ELEVATION.

THE STEAM CATAMARAN MAY BARRETT.

by the hand nut, *f*. The upper part of the cylinder is surrounded by a collar, *h*, which carries an ear by which the standard, *r*, is supported, and a projection to which *q* is articulated, the right line motion of the pencil being obtained by the radius rod and the proportion between its length, the length of *q*, and the position of the joints in the pencil arm, *p*. To prevent water from sprinkling the diagram paper, as it does when holes

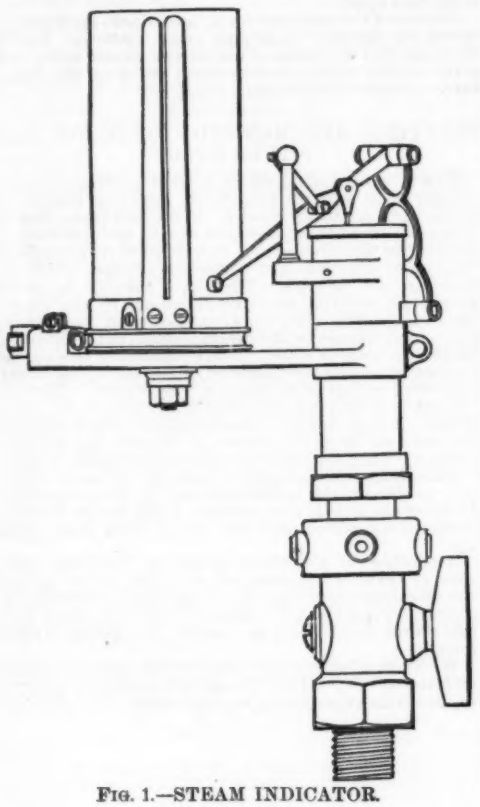


FIG. 1.—STEAM INDICATOR.

for the admission of air above the piston are made in the top cover, they are in this indicator made below the piece, *g*, which carries the paper drum, A. The piston rod, *l*, is of a trunk form at *m*. The spring, not shown, against the resistance of which the steam raises the piston, is of spiral form, and is provided with a nut at either end, by which it is screwed to the piston at *k*, and to the inward projecting boss in the under side of the cover, *c*. The trunk, *m*, or tubular part of the piston rod, slides through the cover, *c*. Within the trunk is the rod, *o*, jointed to the pencil arm, *p*, the lower end of this rod having a ball and socket joint. Our engraving shows the indicator at half size, so that it will be seen that the moving parts are all light. The pencil arm is generally made to carry a metal pencil—for instance, soft brass, to mark on prepared diagram paper. It is, however, also made to take a very hard lead pencil, not only so that ordinary paper may be used, but because some

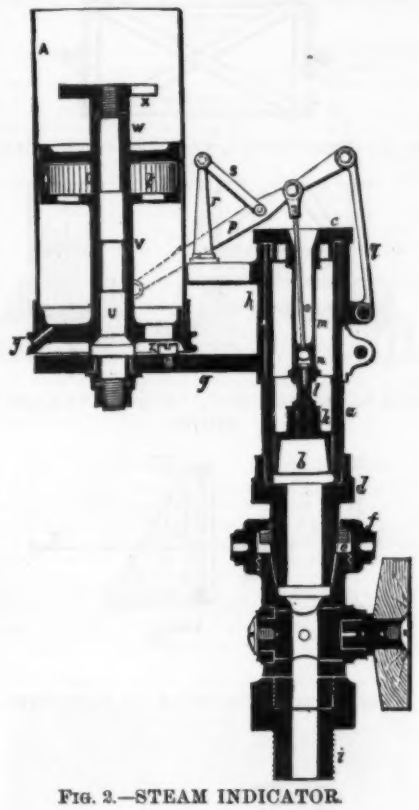


FIG. 2.—STEAM INDICATOR.

German engineers consider that the friction of a hard lead pencil on glazed paper is less than that of a metal pencil on the prepared paper, known as metallic paper, which is more generally used. There is no doubt that the friction of a metal pencil is greater on the prepared paper than a hard graphite pencil on hard paper, especially when the prepared paper, which is much the more expensive, is in a steamy atmosphere.

The paper drum, A, moves upon a steel spindle, V, screwed into the projection, *g*, by an ordinary nut. The tube, V, is loose upon this spindle, and is made in one piece with the pulley, *y*, and the box, *t*, which contains a coiled spring. The piece, W, is a cover for the spring, and is held in place by the nut, X. The drum, A, is fixed to the pulley, *y*, round which is coiled the string by which motion is given to the drum from some part of the steam engine. The string is guided to the pulley, *y*, by a pulley which may be set in any desired direction. The string pulls the drum round

through about three-fourths of a revolution against the resistance of the spring at *t*, which forces it back as the string returns.

The plug of the cock to which the indicator is attached is drilled with holes in two directions, so that, as shown, steam may pass from the engine cylinder to the indicator piston, or by turning the cock in one direction steam may be allowed to blow through to the air from the pipe below the indicator, so that any water in the pipe connections may be blown away. If water is in these connections, especially if they are of any length, it will give to the diagram an irregular form, not representative of any action of the steam in the engine cylinder.

The piston springs constitute one of the most important parts of an indicator, and with these generally we shall deal specially when we have given the reader some further particulars of the indicators most in favor.

The next in order is the indicator invented by Mr. E. T. Darke, and which is illustrated by Figs. 3, 4, 5, 6, and 7. One of the most important features in this is the pencil motion, which consists of one steel arm pivoted at one end by center points on the two ends of a T-head, and carrying at the other a sliding piece, F, which is provided with a holder for a metallic pencil. The pencil is kept in a straight line parallel with the axis of the paper drum by being made to pass through

a slot guide in a plate, C. The piston-rod head carries a jaw, E, and in this is a sleeve, K (Figs. 5, 6), which is an accurate but easy fit on the pencil arm, which is made round at this part. With the motion of the piston and the jaw, E, the sleeve, K, is caused to slide through a small range on the pencil arm as the latter describes an arc on its pivots. The end of the pencil arm, also, in a similar way slides in the piece, F, which is compelled by the slot to keep the straight line of the slot. Our engraving shows the indicator full size. The piston rod is hollow (see Fig. 7). The piston is made

FIG. 7.

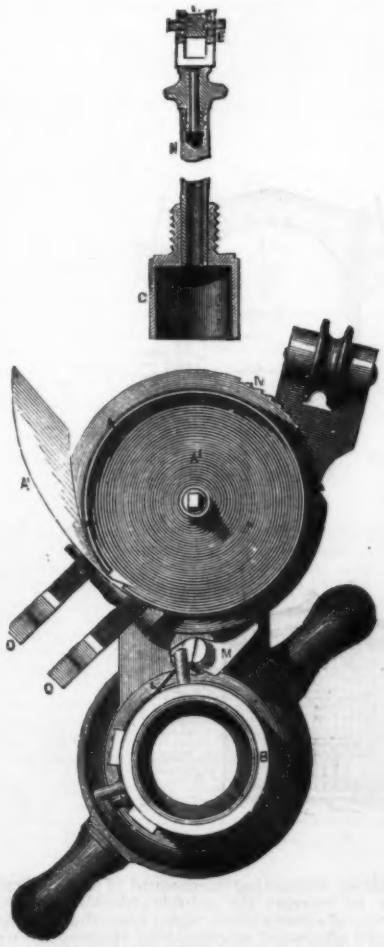


FIG. 4.

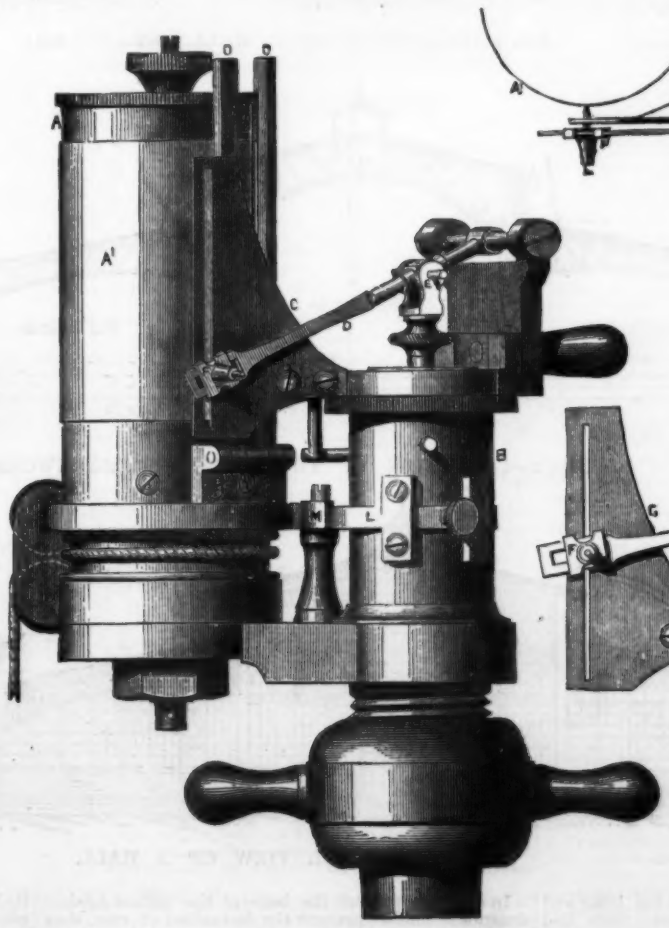


FIG. 3.

FIG. 5.

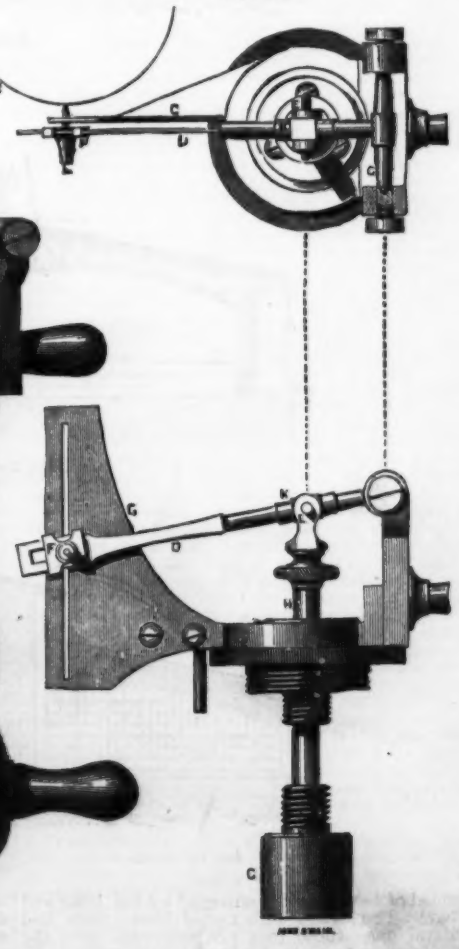


FIG. 6.

THE STEAM ENGINE INDICATOR.

smaller and of shorter stroke than in the Richards, and there are differences in the springs and also in the construction of the jaw head seen in Fig. 7, which we need not describe, as the forms adopted are so well shown in our engravings. In Figs. 3 and 4, Darke's detent gear, which we described in our last impression, is seen at M L, the pawl, M, being out of gear in Fig. 4, but a touch of the knob on the spring, L, will cause it to engage in the teeth at N (Fig. 4) when the drum is pulled round by the string. By this means the drum is stopped without disconnecting the string from the engine.

The piston spring is screwed to the screw on the piston, G (Fig. 6), and to the screw projecting downwardly from the cover, as also seen in the same detached detail drawing, A. As shown in our engravings, the drum is made to contain a roll of diagram paper, A', that part which is outside the drum being held in place by the clip springs, O O. When a diagram is taken, the paper containing it is torn off, the removal in this way bringing forward and placing paper ready for the next diagram. This arrangement is used in most of the Darke indicators, but engineers preferring to put on separate papers may have the drum fitted for this. This indicator is made by Messrs. Elliott Brothers, Charing Cross, and the value of the improvements it contains may be seen from the diagrams (Figs. 8 and 9). The diagram marked B is taken by a Richards indicator from the low-pressure cylinder of a torpedo boat engine, and that marked A from engines of similar construction working under similar conditions, but taken with a Darke indicator. The torpedo boat engines were running at several hundred revolutions per minute. These diagrams show the very great and misleading effect obtained with the high speed engine as due to the momentum of the moving parts of a Richards indicator. The difference in the diagram is equally evident from slower running engines with quick cut-off as in the Corliss engine.

THE NEW CATTLE MARKET AT VIENNA.

THE magnificent cattle market recently erected at Vienna comprises a hall capable of accommodating 4,500 horned cattle, 6 large stables for 900 horned cattle, a hall for 4,000 living calves or 1,500 slaughtered ones, another for 7,000 swine, pens for 4,800 swine, and other spaces for the accommodation of sheep, etc. Each hall consists of metallic columns upon which rests a metallic roof connected by rivets and having the form shown in Figs. 1 and 2. The columns are quadrangular, and are formed of 4 angle irons connected by flat irons and cross bars. The largest walls are of lattice work, and the lateral ones, those that are connected with the trusses of the roofing, are of iron plate strengthened by ribs.

The lower extremity of the metallic columns or pillars are set into cast iron shoes whose bottom is slightly convex, so as to constitute a sort of joint. The extremity of the pillar is itself provided with a steel plate which, owing to the convex form of the internal surface of the shoe, has but a single point of contact with the latter. The result is that the pillar can assume a slightly inclined position when it is submitted to tractive stresses derived from movements due to the expansion of the different parts of the framework (Fig. 4).

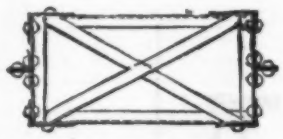


FIG. 3.—HORIZONTAL SECTION OF A COLUMN.

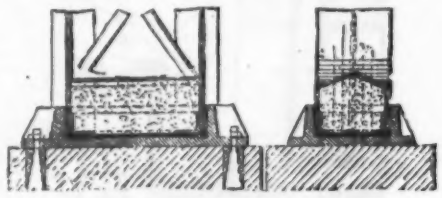
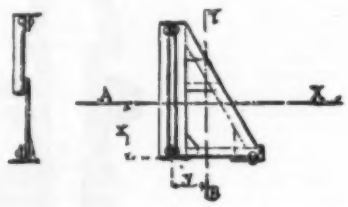


FIG. 4.—ARRANGEMENT OF THE PILLARS AND SHOES.



FIGS. 5 AND 6.—SECTION OF PURLINES

In order to protect the base of the pillars against dampness, and to prevent the formation of rust, they are filled in with fine, dry, white sand, and the latter is covered with a layer of asphaltum. When the latter cracks, as sometimes may happen, more sand will be put in to replace that which has escaped, and the fissures will be sealed up.

Between the external sides of the pillars and the internal sides of the shoe, oakum has been rammed in and covered with asphaltum, so as to form an impermeable joint.

The trusses are latticed, and their top chords are rectilinear and their bottom ones curvilinear. The purlines possess, according to the kind of stress that they have to support, the form shown in Figs. 5 and 6. The covering is of corrugated zinc laid upon planking fixed on wooden rafters. The iron trusses are spaced from 3 to 3½ feet apart.

Certain of the halls are open, and others are entirely closed by metallic walls and glass windows. Fig. 7 shows an end elevation of one of the closed halls, and gives an idea of the architectural effect of the structure.—*Annales des Travaux Publics.*

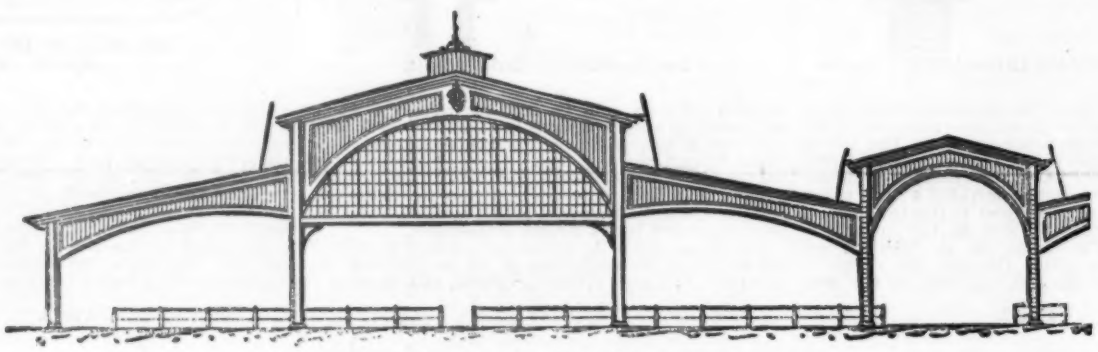


FIG. 1.—ELEVATION OF A HALL. (Scale of 1-400.)

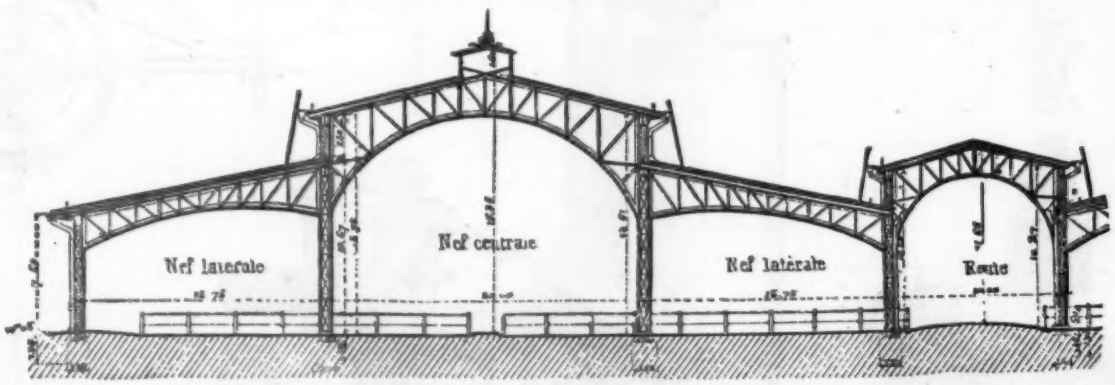


FIG. 2.—ELEVATION OF THE METALLIC FRAMEWORK.

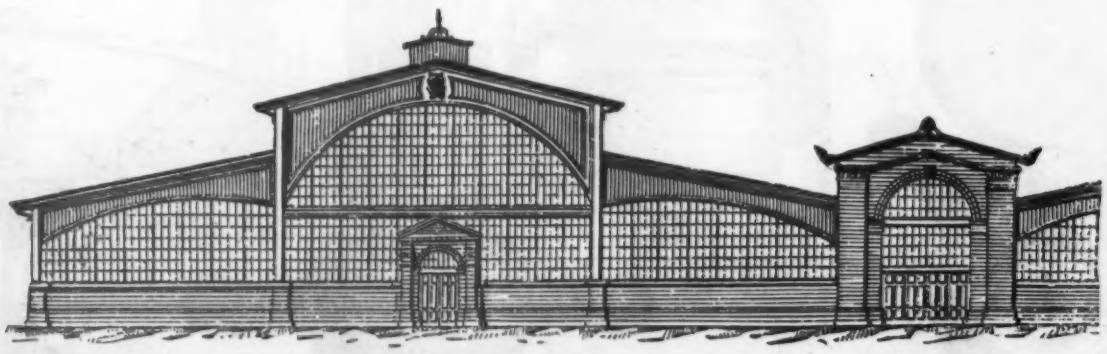


FIG. 7.—EXTERNAL VIEW OF A HALL.

FLOATING ALBUMENIZED PAPER ON THE SILVER BATH.

THE nitrate of silver which is taken up from the sensitizing bath when albumenized paper is sensitized, serves three distinct purposes. In the first place, double decomposition takes place between it and the soluble chloride in the albumen, so as to form silver chloride in the film of albumen, and a soluble nitrate, which remains in the solution. The silver chloride is, as all know, the principal sensitive substance in the paper. There is, besides this, another, however, an organic compound formed by the decomposition of the albumen itself by nitrate of silver. The formation of this second compound is a second function of the nitrate of silver. The third is that of acting as a "sensitizer." The silver chloride darkens only slowly if there be no silver nitrate present, nor any other substance which will take the place of the silver nitrate to absorb the chlorine given off when the chloride of silver is reduced by light.

To estimate the quantity of nitrate of silver necessary to convert the soluble chloride in the albumen into silver chloride is easy enough, if one knows how the albumen was salted, and how much each sheet takes up.

According to a formula given in Hardwich, each sheet of paper of the usual size, 17 x 22 in., takes up with the albumen about 7 grains of ammonium chloride. To convert 7 grains of ammonium chloride into silver chloride requires, as nearly as possible, 22¼ grains of silver nitrate.

We know of no reliable data for the amount of silver nitrate used to produce the organic compound referred to, but from experiments we have made with albumenized paper, estimating the amount of silver nitrate necessary to convert the soluble chloride, noticing the quantity of silver nitrate taken from the bath, and the quantity afterward recovered by thoroughly washing the paper—without exposing it to light—we conclude that the quantity is very small, probably not more than two or three grains to the sheet.

The quantity of free silver nitrate remaining in the

paper after sensitizing may very easily be ascertained. It is only necessary, after sensitizing a sheet, to wash the free silver nitrate out of it with distilled water, and to estimate the quantity of it in the usual volumetric manner. From estimations made by ourselves on the lines indicated, we may say that the amount of silver nitrate remaining in the paper in excess after sensitizing is fairly represented by the actual diminution in bulk of the printing bath. We mean that, for example, if three sheets of paper take up one ounce of a sixty-grain bath, there will remain in each sheet of paper twenty grains of free silver nitrate, the further nitrate required to produce the chloride of silver and organic compound serving only to weaken the remaining solution.

Taking Hardwich once more as an authority, we find that an average quantity of bath to be used up by a quire of paper is eight ounces; that is to say, each sheet of paper removes one-third of an ounce of fluid from the bath.

Our own experience would incline us to put this figure a little higher in ordinary circumstances; the quantity absorbed varies greatly with the paper. Thick paper naturally absorbs much more of the bath than thin paper does. Making an average, we should say that a quire of paper reduces the bath by about nine or ten ounces. Taking this quantity as correct, and supposing the bath to be a sixty-grain one, we find that almost precisely the same quantity of silver nitrate is taken up merely to form a chlorine absorber as is used to form the important sensitive salt. This appears to be somewhat extravagant, and has been felt to be so for a long time. More than twenty years have elapsed since it was pointed out that the silver bath might be greatly reduced in strength if part of the silver nitrate were replaced by sodium nitrate, which would serve as well as the silver nitrate to coagulate the albumen of the film. Doubtless economy resulted; but somehow, so far as we know, the method was never very popular.

There are other methods of economizing, however, which ought to be taken notice of. It is well known to practical printers that it is a great advantage to have the albumenized paper damp before it is floated. The edges do not curl away from the bath in the aggravating manner that they do when the paper is dry, and air-bubbles are less likely to be formed. These advantages are fairly well known, but we do not think that it is known how great an absolute economy there is in using the paper as damp as is practical, this economy arising from the mere fact that much less of the nitrate of silver bath is absorbed by paper when it is damp than when it is dry. We were astonished to find how great an economy really results from the use of damp paper.

Some time ago we were working with a very highly albumenized and very thick paper, which reduced the bulk of the bath very greatly. We noticed that the amount of bath absorbed varied with the dampness of the paper, and determined to find out the extent of the variation.

We first used the paper very dry—as dry as it was practicable to handle it. We discovered that each sheet reduced the bath by more than half a fluid ounce.

We next made the paper as damp as was possible without danger of softening the albumen. We now found that each sheet absorbed barely one-third of an ounce of bath. The prints given by the paper sensitized when damp were of quite as good quality as those got on that sensitized dry. The bath which we were using was a sixty-grain one, and we found the damping of the paper to result in the saving of quite 12 grains of silver nitrate per sheet, or not far short of 380 grains per quire.

Concerning the manner of damping the paper, a few words may be said.

It is a common plan to keep albumenized paper in a damp cellar. In fact, this course is often recommended by dealers in albumenized paper. Many have not a cellar damp enough at their command. Moreover, it is objectionable to store albumenized paper in a damp place. It should merely be placed in such, if such be available, a few days before it is to be used, which often involves some trouble.

Abney recommends that the steam from a boiling kettle be allowed to play on the paper a moment or two before it is sensitized.

The following is the plan we have ourselves adopted: On the shelf of a cupboard which has but one, the albumenized paper is laid flat, the albumen sides of the sheets upward. Half an hour before commencing to sensitize, a vessel of boiling water is placed on the bottom of the cupboard. There is room for the steam to pass up between the front edge of the shelf and the door of the cupboard. The water is replenished from time to time during working. The paper is thus kept very damp, and apart from the saving in silver effected, the comfort in working is greatly increased.—*Photographic News.*

FORMULA FOR MAKING AND DEVELOPING GELATINO-CHLORIDE PLATES.

By T. BAYNTON.*

I MUST commence by stating that I am indebted to Mr. A. Cowan for the emulsion formula, and to Mr. B. J. Edwards for the developing formula, although I have made some slight alteration in them. The members will find that they can, with this kind of plate [sample transparencies from negatives taken during the summer were here passed round], make very beautiful lantern slides, and so amuse their friends and themselves at the same time on these dull winter evenings.

For the convenience of those members who wish to make their own emulsion plates, I will now give the formulæ. Those who do not care to be at this trouble can obtain them from me if they like.

Silver	1 ounce.
Water	10 ounces.
Gelatine (hard)	1 ounce.
Sodium chloride (pure)	½ "
Water	10 ounces.

Let the gelatine soak for a short time, and then dissolve by placing the vessel in water at about 110° F., and warm the silver to the same temperature. Now take into the dark-room, and mix by any of the well-known methods, so as to form a very fine emulsion. It may now be cooled by placing the containing vessel in running water, and when cold, wash, remelt, filter, and coat in the usual way. Expose for five seconds (more or less, according to the density of the negative) to diffused daylight, and develop with—

No. 1.

Neutral oxalate of potash	2 ounces.
Chloride of ammonium	40 grains.
Citric acid	2 drachms.
Distilled water	20 ounces.

No. 2.

Sulphate of iron	4 drachms.
Alum	90 grains.
Distilled water	20 ounces.

Add one part of No. 2 to an equal part of No. 1, but do not reverse this by adding No. 1 to No. 2, or the result will not be so good. If the plate is properly exposed, the result will be a fine purple-black tone in the transparency. If you like a warm brown tone, expose double the time, and add an equal bulk of water to the developer. The development in this case will be much slower. Many different tones may be obtained by using the various developers given by Mr. Cowan. To fix the picture, use one part of hypo to eight parts of water. After fixing and washing, put the plates for half a minute in the following:

Alum	1 ounce.
Sulphuric acid	1 "
Water	20 ounces.

This will dissolve the opalescence caused by the oxalate. The plate must now be well washed, dried, and varnished in the usual way.

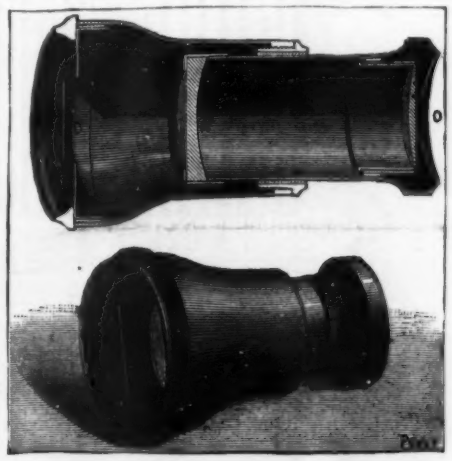
* Read before the Coventry and Midland Photographic Society.

THE PHOTOGRAPHIC ICONOMETER.

THE small apparatus represented herewith is of Mr. A. Rissignol's invention, and is designed to allow traveling photographers to dispense with uselessly placing their apparatus for some time before a subject which is captivating at first sight, but which is so lighted that it cannot give a satisfactory image.

The apparatus consists of a small opera-glass whose lenses are mounted at a fixed distance and have an arrangement contrary to that which is usual.

The objective, N, is plano-concave, and the convex



PHOTOGRAPHIC ICONOMETER.

ocular, O, is of blue glass. The subject (landscape or anything else) is thus seen of reduced size through the effect of the lenses, and without any other color than blue—the only one useful to know. The tube that carries the lenses slides within a second one that is provided at its front end with a rectangular aperture, D, having the proportions of the photographic negative. The object of this arrangement is to restrict the parts of the subject to the space that the objective will represent upon the ground glass of the camera. In order to regulate the instrument and put it in relation with any objective whatever, it is necessary, after placing the camera in position, to sight with the iconometer by drawing the lens tube out until the subject seen through the instrument appears limited by the same objects as upon the ground glass of the camera. A datum point then marked upon the sliding tube will permit of again finding at will the extent to which it is to be drawn out for each objective, and consequently of allowing the subject to be seen in the state that the objective employed will give it, or, conversely, of selecting the objective that is best adapted for obtaining a reproduction of an object within definite limits.—*La Nature.*

MAKING VITRIFIED PHOTOGRAPHS.

A VISIT TO AN ENGLISH ESTABLISHMENT.

SAYS the editor of the *Photographic News*: We recently visited the works of the Ceramic Stained Glass and Vitrified Stained Glass Company at Chingford, and were shown by Mr. H. N. White, the superintendent, the process of making vitrified photographs. The establishment hardly corresponds to the general notion of a "works" or factory, as the cottages are comfortably fitted up in the ordinary house fashion, and are principally occupied by young ladies who are engaged in retouching, painting diapers or borders, and coloring the ceramic pictures. At the back of the cottage is a field, of which a part is laid out as a garden, and beyond the garden beds are three studio-like buildings of wood and glass, while on one side, and as much out of the way as possible, is the stove or furnace where the firing is done.

It is the dusting-on process which Mr. White adopts, and he first took us into the studio-like building where the sensitive plates are prepared, upon which the enamel color is dusted; and it does not follow by any means that the glass or porcelain first coated with the sensitive mixture is that upon which the enamel is finally vitrified, as it is quite easy to transfer the dust image to a new glass or tile. If, however, the image is to be transferred, the glass should be collodionized and allowed to dry before the application of the sensitive mixture. The exact composition of the sensitive preparation used by Mr. White is one of those two things which he keeps to himself, but we know that the mixture recommended for this purpose in Dr. Liesegang's "Handbook of Photographic Enameling"* answers very well, so we will give it here:

Water	100 parts.
Moist sugar	10 "
Gum arabic	10 "
Bichromate of ammonium	4 "

The glass, very carefully cleaned (and collodionized if the image is to be transferred), is now placed on a leveling stand, flooded with the sensitive mixture, and after the composition has been allowed to remain on for a few seconds, the excess is drained off, the plate being now dried in an inclined position. The drying cupboard is contained in the "dark"—or rather, yellow-lighted—portion of the building; but no doors separate the dark-room from the rest, the entry of white light being prevented by hangings of baize arranged on the baffle-plate principle, so that one can walk in or out of the yellow room without touching or disturbing the hangings. The warm cupboard stands on a tin water vessel, scarcely two inches deep, and about two feet wide by five feet long, the whole being closed, excepting that a pipe is provided, by which any vapor may escape. The wooden bottom of the drying box stands directly upon the top of the hot-plate or water-bath, and the front of the box is merely closed by means of a curtain. As the plates are coated, they are reared up on edge in the cupboard, and allowed to remain until quite dry, when they are ready for exposure in the printing-frame. Mr. White tells us that much depends upon care in drying, and that many fail in the working of the dusting-on process through drying the plates at too high a temperature; indeed, he tells us that in warm weather he very often uses no artificial heat at all. "What is the temperature in the cupboard now?" we asked; but Mr. White confesses that he had no idea of the temperature in degrees. To the hand the interior of the drying box seems only a trifle warmer than the external air, and one may perhaps estimate it at about 85° Fahrenheit. The large flat water-bath or hot-plate upon which the cupboard stands is kept sufficiently warm by one paraffin heater with a four-inch wick, and turned down very low. "The special advantage of the hot-water plate is that it ensures a uniform heat all through the bath," says Mr. White; and once more he takes the opportunity of impressing upon us the fact that very little overheating is fatal, as it bakes the mixture, and renders it incapable of again absorbing moisture.

The exposure is made under a transparent positive, and the greatest care is exercised to see that printing frames and transparencies are perfectly dry; indeed, it is generally considered advisable even to slightly warm them before use. More than this, Mr. White called our attention to an apparatus somewhat resembling a gardener's forcing frame, and provided with a heating arrangement consisting of a battery of paraffin lamps. "This is where the printing frames are placed during damp weather," Mr. White said; "and without some such arrangement for keeping them perfectly dry our work would be perfectly uncertain." The exposure required is not a very prolonged one, a single minute in bright sunshine being often sufficient, while in dull daylight half an hour or more may be required. No actinometer is used, it being easy for one who is constantly at the work to judge the exposures with sufficient accuracy. The effect of exposure to light is to destroy the power of absorbing moisture which the sugar and gum ordinarily possess, consequently when the plate is withdrawn from the printing frame and exposed to damp air for a few minutes, those portions which have been protected from the action of the light will hold the vitrifiable pigment which is now dusted over the plate, while the most exposed parts refuse to take up any pigment, because they do not become adhesive by the absorption of water. For dusting with the vitrifiable pigment—which is just such a powder color as potters use in decorating their goods—the plate is laid in a tin dish, and the powder is dusted over with a broad camel's hair brush. If the image is very slow to appear, one may venture to breathe very cautiously on the plate, after which the enamel color is again applied. A little consideration will show that in this process over-exposure results in a hard image, while fog or general tinting is a consequence of under-exposure. When a perfect picture, having all the gradations of the original, is obtained, the excess of pigment is brushed off, and the powder color is fixed by flowing collodion over the plate. If the plate were now fired, the chromium compounds in the film would become vitrified, and would give a disagreeable green tint to the picture, so some means of insuring their removal must be adopted.

One of Mr. White's secrets is the composition of the fluid in which he soaks the plates at this stage to remove the chromium; but Dr. Liesegang recommends soaking for half an hour or so in a two per cent. solution of caustic potash. The preparation used by Mr. White for the removal of the chromium is contained in the largest collection of glass dipping baths which we ever before saw in one place; we counted eighty all placed in a compact row one behind the other, and then gave up the task, as we observed other such rows on another part of the table. The chromium having been removed, and the plate dried, all is ready for the final operation in the furnace, if the vitrification is to take place on the original support; but if the film is to be transferred, the plate must be allowed to remain in very dilute acid (say one part of nitric acid in sixty or eighty of water) until the film can be floated off, and placed in position on the glass or tile which is to be decorated.

As we leave the place where the dusting work is done, we meet an inventive friend of Mr. White, who has just come to tell him that he has discovered a new use for vitrified photographs. "See here," he says, as he fastens to the door of the room a tile bearing a group photograph; "let these portraits be those of the persons employed in the establishment; you mount this upon the door, and when any one goes out you cover him up with a kind of shield hinged on a wire, thus."

* *Photographische Schmelzfarbenbilder.* Ed. Liesegang, Dusseldorf.

This suggestion of the "funny man" not only makes Mr. White smile, but it serves as a text for him to explain his views as to the future of ceramic photography. Mr. White, we may remark, is an enthusiast, and he looks on the burnt-in picture as the photograph of the future. He tells us that pictures on glass need not cost so much as to prevent their general use for window decoration. Not only can you make an album of your drawing-room window, but it may be an art gallery as well, decorated with reproductions of the choicest engravings and paintings; while your library windows may be adorned with portraits of all the great masters in letters.

We have now reached the furnace room, and as we enter we see a row of four cast iron muffles along the side opposite the door and windows. No coal is visible, and for a moment we fancy that the furnace must be fed with gas made on the Siemens system; but no, Mr. White tells us that he is sorry to say that he uses coal, but in order to minimize the inconvenience from its use, he has arranged for all the feed places of the furnaces to be outside and at the back. Wood is, according to Mr. White, the only solid fuel which is quite satisfactory, as this alone is free from sulphur; and he hopes to secure a good supply when the lopping season commences in Epping Forest.

Three of the muffles are large ones, and each has runners for taking twelve iron plates, each of these plates being large enough to carry a square of glass thirteen inches square. The muffles are red hot, and Mr. White is about to fire some plates, but his first step is to draw down the blinds—which, by the bye, are black—and to make the room darker than many a so-called "dark room." "This is to enable me to judge of the heat," explains Mr. White; and he says that it would be quite impossible to form any notion if daylight were admitted. Each plate to be fired, whether porcelain or glass, lies on an even bed of whiting, about a quarter of an inch thick, this whiting being spread on the cast iron plates that slide into the muffles, and in every case the bed of whiting is carefully leveled by means of a thick slab of plate glass provided with a handle. To put the iron plates bearing the sheets of glass directly in the hot muffle would be quite out of the question, so Mr. White has arranged a set of paraffin stoves, one for each iron plate. All these are placed in a row, each one toward the left being turned up a little higher than its neighbor on the right. When an iron plate, with its bed of whiting and sheet of glass, has been heated to the full power of the first stove, it is moved to the next, and so on until it is sufficiently heated to be placed in the muffle without danger of fracture. When the muffle is fully charged, it is closed with a heavy iron door, upon which are two tubular pieces which project forward and fit into corresponding openings in the outer door of the furnace. When this outer door is closed, the flames can circulate all round the muffle, but cannot reach the interior. Still, in the case of colored work, Mr. White finds mischief to result from the sulphur of the coal, so he has put himself to some pains to arrange for the ventilation of the muffles by means of tubes leading from the upper part into the open air. The firing does not take long, but the cooling is a slow process, as, if the glass is rapidly cooled, it is so liable to break as to be useless; indeed, two charges a week, or at most three, are as much as can be fired if the plates are properly annealed.

Besides the three large cast-iron muffles, there is an experimental muffle, built up out of fire tiles, and in front of this hangs a framed sheet of glass, balanced sash-fashion by weights—a very necessary protection to the eyes during experimental work.

The photographic department is in one of the three glass-houses already referred to, and the first thing to attract our attention is one of Ottewell's old cameras for making large portraits direct, the lens being a Jamin of nearly seven inches in diameter. Although the slide of this apparatus will take a 16 by 14 plate, it is in daily use for the smallest sizes. Mr. White is a little conservative in his notions; he holds strongly to the superior advantages of taking large portraits direct, and has only worked the gelatino-bromide process during the past few months; in pointing to his large bath, and the four half-gallons of solution required to charge it, he could not help expressing regret at keeping it to look at rather than to use.

The dark-room is at the other end of the glass-house, and is partitioned off by doors sliding in deep grooves, so that the whole length can be thrown into the studio if required—an excellent arrangement for those who may wish to work with lenses of long focus.

Outside the studio we find a number of ceramic pictures nailed up; and inquiring the reason why, "It is to test their power of resisting the weather," we are told; but in no case have they shown any indication of deterioration, although they have been exposed for three years. Still, if a picture should not be sufficiently fired, or if the flux-color contain too much lead, enamels will be liable to damage by exposure.

It should be mentioned that many of Mr. White's pictures are vitrified on opal glass, and he told us that the English flashed opal is the only material upon which he can depend, the foreign pot opal melting completely at the temperature required for a proper vitrification of the colors.

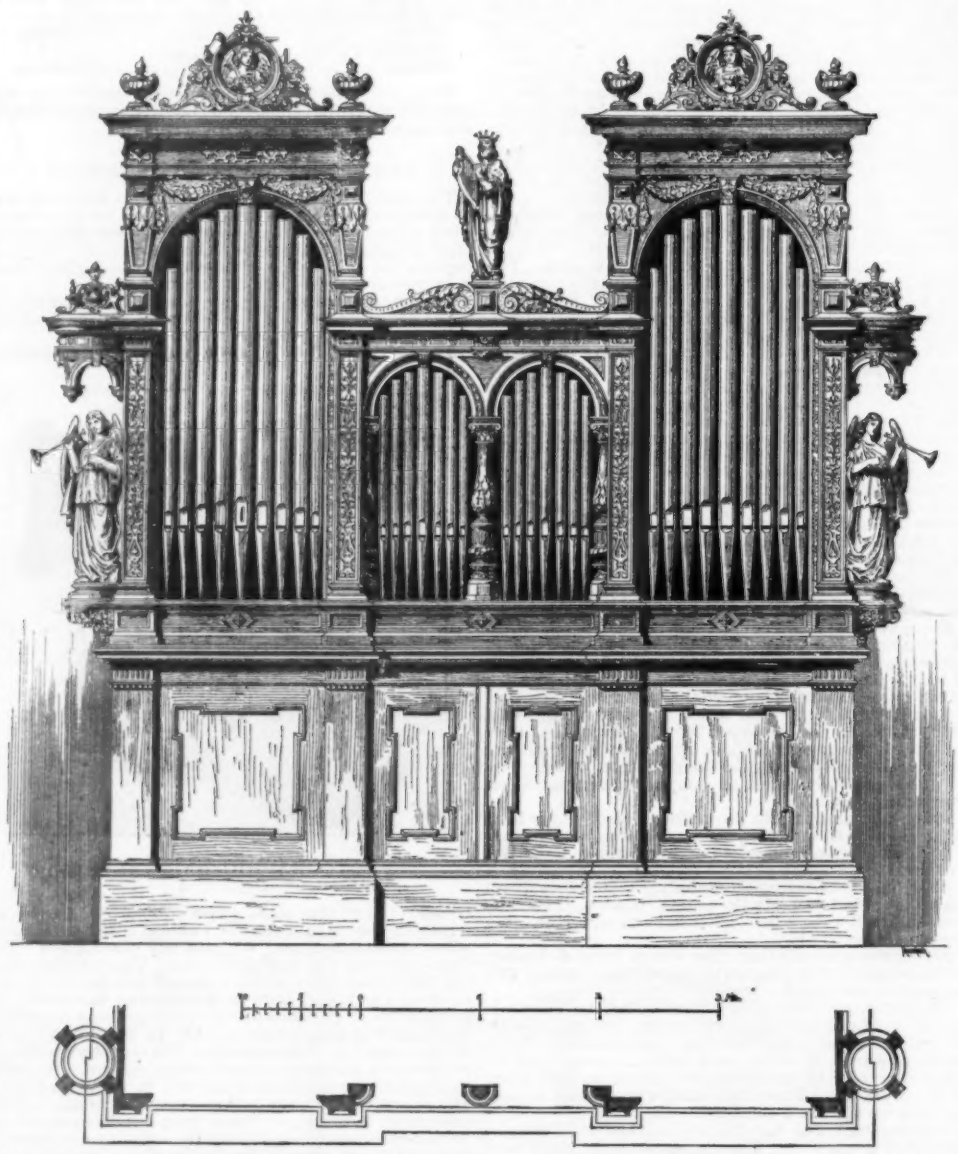
Several medals have been awarded to Mr. White for his productions, among which may be mentioned those of the Edinburgh Art Society and the Cornwall Polytechnic Society; while the Glass Sellers' Company has conferred upon him the honorary freedom of the Company, as well as its silver medal.

UTILIZATION OF CORK CHIPS.

FEW years ago a product has been introduced in commerce called corkstone, and the expectations entertained in point of application have been surpassed during the brief period of its use. For information regarding the manufacture and manifold application we are indebted to A. Wagner, and thus follow him in his description: Refuse of cork is reduced by means of machinery to the size of a bean, and intimately mixed with a mortar of air-lime and clay. The pasty material being pressed in suitable moulds, is dried in ovens at 120° to 130° C. The product represents now an exceedingly porous material of low specific gravity, and resembles pumicestone. The specific weight is but 0·3, and a brick made from this material weighs 0·6 kilo, while such of ordinary clay has a weight of 3·8, and that of pumicestone of equal size, 2·2 kilos. As to solidity, corkstone resists a strain of 2·8, pumicestone of 4, and common brick of 7 kilos per unit of surface. Cork is a bad conductor of heat, and so is corkstone; the latter is not affected at a temperature of 180° C., can be cut with a knife and saw, and readily yields to the blows of a hammer. For partitions in dwelling houses and warehouses it is not exceeded, and is in many cases preferable to bricks, notably as material for arches, vaults, and ceilings, augmenting but slightly the strain upon the sub-structure and adhering well to lime-mortar and gypsum. The corkstone is well adapted for isolating purposes, and thus used with advantage in the construction of ice houses, hot and drying chambers, boiler houses and floors, also as a covering for steam-boilers, steam and water pipes. By grinding cork chips very fine and employing potato starch as binding material, a mass is obtained which can be moulded into flat tiles or shaped into circular coverings for steam and water pipes. Trisulphide is insoluble in dilute acids and that the so-combined sulphur does not act upon silver sheet. Arsenic sulphide contains 39·02 per cent. sulphur, and which metal, when present in comparatively large quantities, can combine with a large amount of sulphur. The following results have been obtained, *a* by means of the silver test, and *b* by precipitating sulphur as sulphate of barium:

	Arsenic.	*a.*	*b.*
Cast iron.....	0·070	0·03	0·555
Cast iron	0·030	0·03	0·035
Wrought iron, I. .	0·090	0·03	0·042
Wrought iron, II.	0·045	0·15	0·022

Wrought iron marked I. was brittle, and that under II. was in every respect of excellent quality.



SUGGESTIONS IN DECORATIVE ART.—ORGAN FOR ST. ANDREW'S, GRAZ.—*From The Workshop.*

NEW METHOD OF HEATING THE REGENERATIVE GAS FURNACE.*

By Mr. FREDERICK SIEMENS.

IN every description of furnace which has hitherto been designed, either for heating or melting, it has always been considered that the first condition of successful working was to make the space to be heated as small as circumstances would allow, so that the flame might be brought into as intimate contact as possible with the inside lining of the furnace, and more especially with the material under treatment. This method of constructing and working furnaces, which was a necessary condition of success in all cases in which it was proposed to obtain a high temperature with the use of solid fuel, was also adopted in regenerative gas furnaces, which until quite recently were heated on the same principle; the author, however, has for some time doubted the correctness of this view, and from experience gained in the practical working of this class of furnace, after long and careful trials, has satisfied himself that they should be arranged so that the flame should only radiate heat upon the material to be heated or melted, and not come into actual contact with it, as has hitherto been the case. Further practice on the same lines has led to the development of the mode of heating to which he wishes to draw the attention of the Iron and Steel Institute on the present occasion. The gas and air ports, instead of being so arranged that the flame shall impinge upon the materials placed on the bed of the furnace, as hitherto, open at some distance below the roof of the melting chamber, and at some distance also from its side walls, so that the gas and air after ignition, have unobstructed space for entering into combustion, and for the free development of the flame, which is kept as much as possible from contact with the roofs, walls, or materials on the furnace bed; and when these are crucibles, ingots, blooms, or packets of iron, they should be placed sufficiently far apart to allow the radiant heat to have free access all around them. Where there are working doors, the flame should pass above their level; in this way the men will not be inconvenienced while watching operations inside the furnace; but, as already mentioned, the main object to be secured is to avoid contact of the flame with the materials under treatment or with the walls of the furnace.

In constructing furnaces according to this new method of heating, the air inlet may be arranged above the gas inlet, thus forming two parallel horizontal ports for the delivery of the gas and air in broad streams into the furnace chamber, the inflowing air overlapping the gas at each side; the gas and air may be brought into the furnace chamber in several streams side by side, the air ports, which are more numerous than the gas ports, being also placed at a higher level than the latter; or, again, as used in connection with a crucible steel-melting furnace, as the length of travel of the flame is comparatively short, the gas is brought into the chamber by two ports, having an air port between them, and additional air ports on either side, the ignition commencing as soon as the air and gas, which are delivered in thin streams, reach the height at which the flame is to travel across the furnace from end to end. This arrangement is one which could be applied in other cases, where, on account of the shortness of the melting chamber, the air and gas have to be well mixed on ignition to secure complete combustion before their exit at the other end of the furnace. In cases in which there is a great length of travel for the flame, the ignition is retarded by means of a horizontal wall or tongue, so that it shall only take place at the entrance of the gas and air into the furnace chamber, and the combustion may be extended throughout the furnace, the flame in this case taking a semicircular or horseshoe course.

The furnace as now built, appears at first sight to be unnecessarily high and wide, but this new method of heating high temperature furnaces by radiation re-

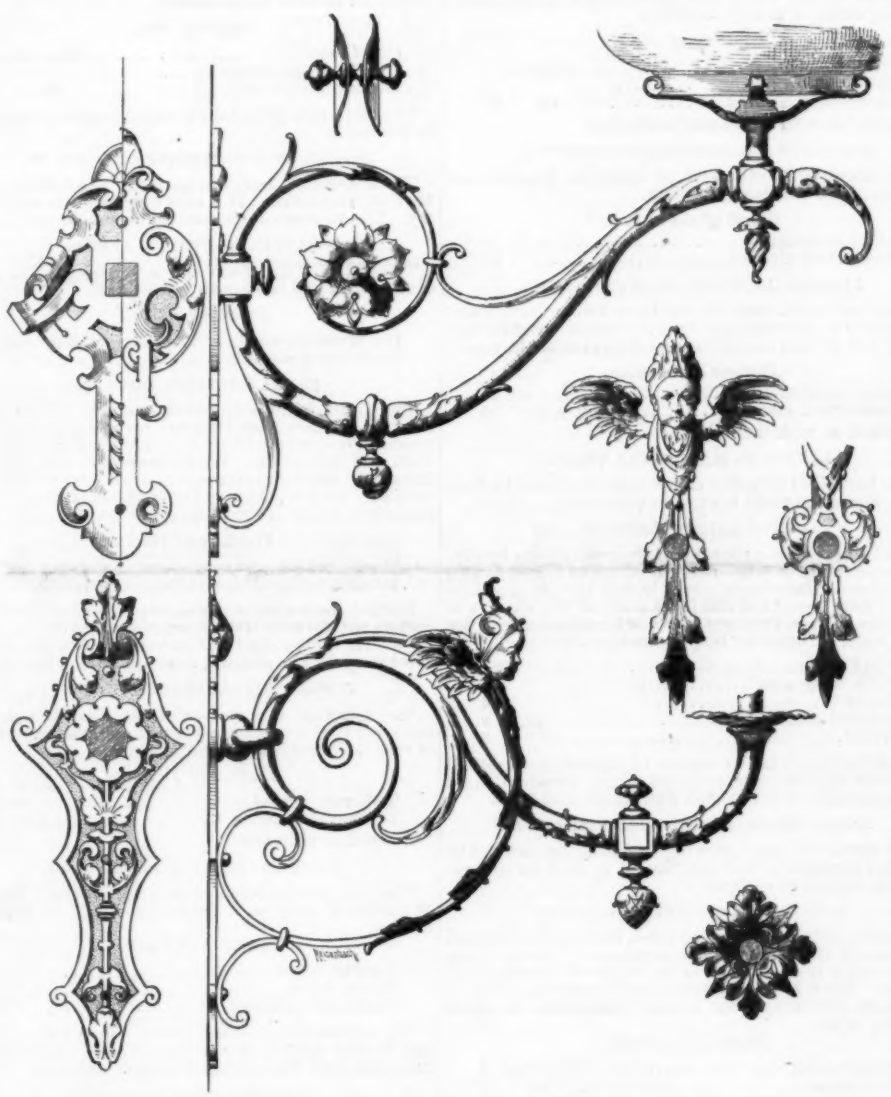
*Paper read at the Chester meeting of the Iron and Steel Institute.

quires a large space for the development of the flame, and for securing the advantages which may be obtained by its use. In order to realize the circumstances under which these benefits are obtained, it must be borne in mind that in the regenerative gas furnace the amount of fuel used does not depend so much upon the intensity as upon the quantity of heat required; whereas in the old furnaces, in which direct combustion of solid fuel takes place, intensity can only be obtained by means of a strong chimney draught or a blast, and the consumption of very large quantities of the best fuel; and even with their use the highest temperatures required in the arts are difficult to get, and still more so to maintain, the difficulty and expense increasing with the size of the furnace.

Thus it has been ascertained that in an ordinary crucible steel-melting furnace, heated by means of solid fuel, about 2 per cent. only of the heat developed is taken up by the steel, so that nearly the whole of the great mass of coke used is expended in getting up and maintaining the furnace at steel-melting temperature.

In a regenerative gas crucible steel-melting furnace, on the other hand, when once the steel-melting temperature has been reached, it is easily maintained with a moderate chimney draught, and therefore by the burning of a comparatively small quantity of fuel, which may be of a poor quality, so that the greater part of the heat of combustion is taken up by the steel, does the regenerative gas furnace lend itself to this mode of construction and of application of the flame, but experience proves that great economy in fuel is thus effected, to which must be added in many cases the indirect saving obtained by a considerably increased output and the improved quality of the material produced when it is not exposed to contact with the flame, while the furnaces themselves last much longer. There can be no doubt that the very remarkable results of improved quality and increased output of material, with a longer life of the furnace, can only be brought about when the active flame is not allowed to act upon the materials within the furnace, the interruption of the processes of combustion by the interposition of solid bodies always tending to injure or even to destroy them.

But besides the circumstance that solid bodies are injured by flame, it can be easily shown that when flame is brought into contact with any solid body, it is more or less quenched, according to the substance, size, and temperature of the body. A very simple experiment in proof of this, and one which is familiar to most people, is the following: Take any ordinary illuminating gas flame, such, for instance, as a batswing, and place a glass rod or tube into the middle of it; the flame will immediately burn dull, and a large quantity of lamp-black will be deposited on the piece of glass. This action is most marked when the rod is cold, but



SUGGESTIONS IN DECORATIVE ART.—GAS BRACKETS.—*The Workshop.*

while what remains amply suffices to maintain the crucibles and furnace at the necessary temperature, and only a very small quantity escapes through the chimney.

The following is an actual comparison between an ordinary reheating furnace using solid fuel and one on the regenerative gas principle. The former uses about three tons of a fair quality of coal in a shift of ten hours, while a regenerative furnace of equal capacity takes about two tons for the same time, there being a saving of 33⅓ per cent. But if both furnaces are merely kept at a welding heat without any cold iron being charged, then the solid fuel furnace requires about 2½ tons of coal per ten hours, while the regenerative gas furnace takes half a ton at the outside; so that, when it is only necessary to maintain a certain temperature, the regenerative gas furnace shows an economy of 80 per cent., while it is 33⅓ per cent. when both furnaces are bringing iron up to the welding heat. The results here given are from the author's personal observation, but in some cases the advantages gained by the use of the regenerative gas furnace for heating purposes have been greater, reaching from 40 to 50 per cent.

It is evident from the above considerations that in regenerative gas furnaces a flame of very high temperature is obtained, such as is required for working by radiation, while the greater part of the heat so produced is taken up by the material charged, and that therefore there is no reason why the heating chambers of these furnaces should not be enlarged to any reasonable extent, and at the same time be built so that the flame does not come into contact either with the sides and roof or with the material to be heated. Not only takes place, though in a less degree, at any temperature, for the reason that the material to be heated is necessarily always at a lower temperature than the flame, also owing to the disturbance in the combustion caused by contact of the solid substance with the flame. The author hopes shortly to treat this subject more fully, from a physical point of view; but the experiments he has made establish the following most important fact, namely, that a good flame, or, in other words, perfect combustion, can only take place in an open space, or in one of sufficiently large size to allow the gases to burn out of contact with solid material.

To show more clearly the advantages which have been so far derived from the application of this new system, it will be well to give a few examples of comparative results in working regenerative gas furnaces constructed on the old and new principle. A glass pot furnace built at Dresden ten years ago, and which has been reconstructed for experimental purposes, shows the economy of this method of heating most effectively. This furnace held ten pots, and melted glass every night which was worked out during the day, giving a daily production of about 3,000 bottles in a shift of seven hours, or, after allowing for pot breakages, a monthly production of 70,000 to 80,000 bottles. The pots lasted about three weeks, and the furnace itself about six months; during this time it required many repairs, which naturally interfered with its production. At present the same furnace, supplied with the same quantity of fuel, and working the same charges, produces daily 5,000 bottles in a shift of nine hours, amounting to a monthly production of 130,000 to 140,000 bottles. Fewer pot breakages also occur, less repairs are required, and the amount of waste has decreased; moreover, the glass metal is obtained from a cheaper composition than hitherto used, and proves to be of a far superior quality. The pots last fully double the time, and melt more than three times the quantity of material, while the furnace itself stands for three years; that is, it lasts six times as long, and melts more than nine times the quantity of material it did, previously to its reconstruction. As the flame is kept away from the working holes, the glass-blower is able to work more at his ease and to turn out a better product, besides being able to heat his glass in the furnace without tarnishing it. There are also several other advantages of a minor character, which, with those already referred to, enable the glass-blower to supply over 50 per cent. more goods without much greater exertion on his part.

Another furnace, from which glass lamp chimneys are made, gives still more favorable results. The mixture employed is much more refractory than before, and the glass produced is of a better quality and of a whiter color, while the glass-maker is now able to produce this superior kind of glass in open pots; that is, in the same manner as common glass is made. The result is, that the closed pots formerly used for melting the finer qualities of glass, in order not to expose the batch or mixture to the direct influence of the flame, are no longer required, whereby a considerable saving in pots and in fuel is realized.

Similarly advantageous results are attained in the open-hearth steel-melting furnace. At the Landore Siemens Steel Works, near Swansea, the furnaces which were altered at the end of last year and at the beginning of this to this new method of heating have already outlasted the furnaces reconstructed upon the old type at the same time, while they work more uniformly, giving an improved and larger output, owing to less oxidation of metal, as is proved by more ore being required per ton of pig iron used in order to decarbonize it to the same extent. The life of these furnaces is expected to be five or six times as long as that of the old furnaces, while great economy in the consumption of fuel per ton of steel melted should be realized. This method of heating is now being adopted at several other steel-melting works in this country, and will be found particularly advantageous where steel is intended to be made from inferior qualities of pig iron by the adoption of a basic lining.

Another important application of this method of heating is to forge, mill, and pudding furnaces, as, owing to the absence of contact between the flame and the materials with which the furnace is charged, a great reduction in the loss of metal, which has hitherto occurred through oxidation, will be effected.

In steel reheating furnaces, contact of the flame with the ingots produces red-shortness in the metal, exhibiting itself in fissures, particularly at the corners of the ingots or blooms, when these are subjected to treatment either under the hammers or in the rolls. The removal of the injured portion involves a stoppage of the operations, resulting in a waste not only of material but of time also, and occasionally rendering the blooms entirely useless for the purposes intended. In the radiation furnace this cause of loss will no longer exist, while there will also be a saving due to non-oxidation of the metal.

In iron reheating furnaces the gain in metal will be much more considerable that in furnaces for the reheating of steel, owing to the higher temperature at which they are worked, and the metal will weld much more easily, as it is heated out of contact with flame. These furnaces should be made as long as convenient, in order to obtain as much room for the development of the flame as possible, and for placing the ingots, blooms, or packets sufficiently far apart to allow the radiant heat to reach them on all sides.

In applying this new method of heating to puddling, it might be advantageous to erect a furnace containing a number of pans, which could either be placed in two rows, the men working at each face of the furnace, or the men could work all on one face by constructing the furnace of a horseshoe form.

For many other applications of the new system experiments have either been prepared or trials already made; for instance, for heating boilers by means of gas. When it is considered that the temperature of the water in a boiler working at 60 lb. pressure on the square inch is only 311 deg. Fahr., while the temperature of gaseous flame may be taken at 4,000 deg. Fahrenheit, it will readily be perceived what a quenching effect the metal of the boiler, which is of course at the temperature of the water, has upon the flame. In this case the principle has been followed of letting the active flame consume itself in the open space of the tube without allowing it to touch the sides until after complete combustion has been effected, when the products of combustion may be brought into direct contact with solid bodies. By such an arrangement complete and smokeless combustion is obtained, with the result of longer life to the boiler, the sides of which more readily deteriorate through direct contact with the flame than from any other cause. As the heat of the flame which is not transmitted by radiation, comes after complete combustion into direct contact with the sides or flues of the boiler and its regenerators, it is completely utilized, and a saving of fuel to the extent of 25 per cent. is secured by this method of heating.

The results obtained in actual practice show that there can be no doubt that almost all heating apparatus used in the arts, in which direct contact of flame with the substances treated is not necessary for chemical reasons, will be materially improved by the application to them of the principle of transmitting the heat of flame by radiation only, while the heat of the completely burnt products of combustion is better utilized by contact.

Complete combustion of fuel is insured by this method of heating, and it will therefore entirely abolish the smoke nuisance. Smoke is never formed when combustion is complete, being always caused by flame coming into contact with solid bodies, the process of combustion being thereby checked. This is, for instance, the reason why brick kilns generally smoke so abominably, for in them scarcely developed flame is forced to impinge immediately on cold bricks, and can therefore only act in a very incomplete and uneconomical way. The author has frequently made the observation, with regard to regenerative furnaces, that a short combustion chamber invariably gives very unsatisfactory results, and accounts for it by the fact that the flame is hardly formed before it has to pass through the outlet

ports and into the checker work of the regenerators, where its combustion is checked, and smoke is formed in consequence. To work well, a brick or pottery kiln should be so built that the flame can burn itself out in a free space before being brought into contact with the bricks or pottery. Zinc-distilling furnaces, and in fact all furnaces in which muffles, tubes, crucibles, and other vessels are used, will in the same way be much more economically worked on this new principle.

From these various descriptions of the regenerative gas furnace, as now applied, it will be readily understood that the heat of the flame is utilized in two distinct conditions and periods, the one following the other. The radiation period, with its active combustion of the highest possible intensity, is limited to the furnace chamber, which is made of ample dimensions, so as to allow the flame free space to develop without obstruction to its chemical action by intervening objects; while after combustion is at an end, and radiation ceases to be effective, the products of combustion in passing through the loose brickwork of the regenerators, deposit their remaining heat by getting into close contact with the large surface of the bricks.

This system of utilizing the heat of flame in two successive stages is the most economical as regards the consumption of fuel, and ought to be the ideal aimed at in all heating operations.

In conclusion, I may add that although the regenerative gas furnace has been well known and appreciated on account of its economy and efficiency for many years past, it will, when the principle of the exclusive use of the radiant heat of the flame to the heating chamber is applied in a thorough and efficient manner, give results which will far surpass any that have been obtained from it hitherto, and that its application in the arts will be multiplied to a degree which even its warmest admirers would scarcely have thought possible a short time ago.

PERFUMES, AND FORMULAS FOR THEIR MANUFACTURE.*

By JACOB JESSON, Muskegon, Michigan.

THE query, "How far is it expedient for pharmacists to manufacture their own perfumes, and what formulas can be proposed for their manufacture?" may be answered with the statement that it is expedient so far as the pharmacist may desire pleasure and profit from his business. The art of manufacturing perfumes by right belongs to the pharmacist, but it has drifted into the hands of specialists, owing to the general impression that it is something mysterious and difficult. I assure you, however, that it is not difficult, and every pharmacist of ordinary intelligence should be able to supply his trade with goods equal to those produced by domestic or foreign specialists. The outlay required is small compared with the profits derivable from the investment. The essential oils and pomades required can be obtained from wholesale druggists, and in the desired quantities. The formulas herewith presented have been in use by me for the past seven years, and may be accepted as reliable. . . . I have divided the subject into three parts: (1) a short description of each article, and the mode of preparing the tincture, spirit, or essence; (2) the amount and cost of material required; (3) a number of formulas, with the cost of each. The materials entering into the manufacture of perfumes are obtained in different parts of the world, and from the vegetable and animal kingdoms.

ALMOND (AMYGDALA AMARA).

Is a native of Persia, Syria, and Barbary, and is cultivated in southern France and Italy.

Almond Spirit.

Oil of bitter almonds	drops	80
Deodorized alcohol	oz.	16

Procure the best cologne spirits or deodorized alcohol obtainable. Do not use common alcohol, as its odor is too strong and pungent for perfumers' use.

AMBERGRIS.

This substance, which is found floating in the sea, or is thrown up by the waves upon the shores of various countries, is now generally believed to be produced in the intestines of the sperm whale. The best gray ambergris is quite expensive, but is the only one worth buying.

Tincture of Ambergris.

Ambergris	drachms	2
Powdered orris root	"	2
Deodorized alcohol	oz.	16

Grind the ambergris and orris in a mortar until reduced to a fine powder; transfer to a bottle, and add the alcohol. Macerate for thirty days, and filter through paper.

BENZOIN (BENZOINUM).

Benzoin is imported from Borneo, Java, and Siam. The tincture of benzoin has the property of adding permanence to some of the more fleeting odors.

Tincture of Benzoin.

Gum benzoin, in fine powder	oz.	2
Deodorized alcohol	"	16

Macerate for thirty days, and filter.

BERGAMOT (CITRUS BERGAMIA).

The oil is obtained in Italy by expression from the peel of the fruit. It should be kept in a dark place, and in a tightly corked bottle. If not well taken care of it soon loses its green color, becomes cloudy from a deposit of resin, and acquires a turpentine smell. Care should be taken to preserve all oils as above directed.

CASSIE (ACACIA FARNESIANA).

Cassie is cultivated in southern France and Italy, and produces a very valuable perfume, resembling violets, but stronger.

Essence of Cassie.

Cassie pomade	oz.	16
Deodorized alcohol	q. s. or "	16

Introduce the pomade and alcohol into a Mason fruit jar of half gallon capacity. Digest by means of a water bath until the pomade is barely melted; shake well together, and repeat the shaking frequently until cold. Allow this to stand thirty days, then drain off the essence. If this falls short of one pint, repeat with a sufficient quantity of alcohol to make up that measure. The washing can be continued, and a second pint of essence obtained, which, although much weaker, may be found useful in a cheaper grade of perfumes.

CLOVE (CARYOPHYLLUS).

The clove tree is one of the most elegant trees found in the Moluccas and other islands of the Chinese seas. Clove is a leading feature in some of the fine bouquets.

Spirit of Cloves.

Oil of cloves	drachms	4
Deodorized alcohol	oz.	16

CITRONELLA (ANDROPOGON MARDUS).

Oil of citronella is obtained by distillation from citronella grass, a native of Ceylon and India.

CIVET (FROM VIVERRA CIVETTA).

This substance is secreted by the civet cat. It is found in a large double glandular receptacle, between the anus and pudendum. The cat abounds in portions of Asia. Civet has a most disagreeable odor, but as a fixing substance, for giving permanence to the more fleeting odors, it is very valuable.

Tincture of Civet.

Civet	drachm	1
Powdered orris root	"	1
Deodorized alcohol	oz.	16

Proceed as with tincture of ambergris.

GERANIUM (PELARGONEUM CAPITATUM).

Geranium oil is obtained in southern France and Turkey, from rose leaf geranium.

Spirit of Geranium.

Oil of geranium	oz.	1
Deodorized alcohol	"	15

JASMINE (JASMINUM ODORATISSIMUM).

Jasmine is cultivated in southern France and Italy. Its odor is so peculiar and fine, it cannot itself be imitated, but is used for imitating odors of other flowers.

Essence of Jasmine.

Jasmine pomade	oz.	16
Deodorized alcohol	q. s. or "	16

Proceed as with cassie.

LAVENDER (LAVENDULA VERA).

The best oil of lavender comes from Mitcham, in England, where the plant is grown extensively.

LEMON (CITRUS LIMONUM).

The lemon tree is a member of the great Citrus family. Sicily produces a large amount of oil of lemon. The raising and extracting of oils of lemon, orange, and bergamot form one of the chief industries in the vicinity of Palermo. A good *essence of lemon* for dispensing or for soda water syrups may be prepared as follows:

Oil of lemon	drachms	4
Carb. magnesia	"	4
Sugar	"	4
Deodorized alcohol	oz.	8
Water	"	8

Dissolve the oil in two ounces of alcohol; triturate in a mortar with the magnesia and sugar. Gradually add the remainder of the alcohol and water, and filter.

LEMON GRASS (ANDROPOGAR CITRATUS).

Is a species of grass growing in India; on account of its odor resembling verbena, the oil is used for preparing the extract of verbena.

MUSK (FROM MOSCHUS, MOSCHATUS).

Musk is obtained from the musk deer, a small animal inhabiting the mountainous regions of Central Asia. Grain musk is the best form in which to purchase the article. Musk is used extensively in perfumes, both as a simple extract and for giving permanence to more fleeting odors.

Tincture of Musk.

Grain musk	drachms	2
Hot water	oz.	1
Deodorized alcohol	"	15

Rub the musk to a fine paste with the hot water. Digest in a covered mortar for two hours, add the alcohol, and transfer to a tightly corked bottle. Digest for thirty days, and filter.

ORANGE (CITRUS AURANTUM; CITRUS BIGARADE).

From the orange tree is obtained five distinct and valuable perfumes. 1st. The true flower odor, obtained by digesting the flowers with lard; 2d, oil neroli petale, or oil neroli bigarade, by distilling the flowers of the sweet and bitter orange respectively; 3d, oil of neroli petit grain, by distilling the leaves and unripe fruit; 4th, oil of orange, Portugal, obtained by rolling the fruit in a metal cup covered with spikes, known as an ecuelle, which wounds the fruit and causes the oil to flow from the oil glands; 5th, commercial oil of orange, obtained by expressing or distilling the orange peel. The orange tree is cultivated extensively in southern France, Italy, and Sicily.

Essence of Orange Flowers.

Orange flower pomade	oz.	16
Deodorized alcohol	q. s. or "	16

Proceed as with cassie.

Neroli Spirit.

Oil neroli petale	drachms	4
Deodorized alcohol	oz.	16

ORRIS (IRIS FLORENTINA).

Is largely cultivated near Florence, Italy.

Tincture Orris.

Orris root pulverized	oz.	8
Deodorized alcohol, enough to make	"	16

Prepare by percolation.

PATCHOULY (POGOSTEMON PATCHOULI, LINDLEY).

Patchouly is a native of Selhet, a district of Bengal. It is also found in Java, Ceylon, and portions of China. The oil is distilled from the fresh herb. It has a very peculiar, musty, mossy odor; but when properly blended, forms a very fashionable perfume.

PIMENTO.

The allspice tree is a native of the West Indies, Mexico, and South America. The oil is obtained by distilling the berries.

ROSE (ROSA CENTIFOLIA).

This is truly the Queen of Flowers; and although roses are found growing wild in nearly every part of the world, it is only in France, Turkey, and India that they are cultivated for their perfume. The Turkish oil is the one commonly found in the market. Oil of rose should congeal at 80 degrees F. When slowly cooled to 50 degrees F., the oil becomes a transparent solid, interspersed with numerous slender, shining, iridescent scale-like crystals (U. S. P.). The oil is obtained by distilling the flowers with water.

Essence of Rose.

Rose pomade	oz.	16
Deodorized alcohol	q. s. or "	16

Proceed as with cassie essence.

Spirit of Rose.

Oil of rose	drachms	2
Oil of rose geranium	"	1
Deodorized alcohol	oz.	16

The oil of rose geranium is added to give permanence to the spirit.

ROSEMARY (ROSMARINUS OFFICINALIS).

The rosemary plant is a native of the borders of the Mediterranean Sea. It is also cultivated in this country. The oil is one of the leading ingredients in cologne.

SANTAL (SANTALUM ALBUM).

The oil is distilled from the wood, which is a native of Australia and the South Sea Islands.

Spirit of Santal.

Oil of santal wood	drachms	2
Deodorized alcohol	oz.	16

TONKA (DIPTERIX ODORATA).

The Tonka bean is the fruit of a large South American tree. When fresh they are very fragrant, having a strong odor of new mown hay. They are exported from Para and Angostura. Tonka beans are used for scenting snuff; and by unscrupulous dealers for adulterating vanilla. And in perfumery in the form of tincture they enter into many of the leading bouquets.

Tincture of Tonka.

Tonka beans	oz.	6
Deodorized alcohol, a sufficient quantity.		

Reduce the beans to a coarse powder; macerate in a corked bottle with sixteen ounces of alcohol for thirty days. Then filter, and add enough alcohol through the filter to make the product measure sixteen ounces.

TUBEROSE (PALEANTHES TUBEROSA).

The tuberose is a native of the East Indies. It is cultivated for its perfume in southern France. Its odor is very fine, and is a general favorite.

Essence of Tuberose.

Tuberose pomade	oz.	16
Deodorized alcohol	q. s. or "	16

Proceed as with cassie.

VANILLA (VANILLA PLANIFOLIA).

The best vanilla beans come from Mexico. Tincture of vanilla is used as a fixing ingredient in some perfumes.

Tincture of Vanilla.

Vanilla beans	oz.	1
White sugar	"	1
Deodorized alcohol	"	16

Cut the beans into small pieces. Beat with the sugar in a mortar until they are reduced to a coarse powder. Macerate with the alcohol for thirty days, and filter.

VIOLETS (VIOLA ODORATA).

A very delicate odor, but very fleeting; by the addition of some of the stronger perfumes a very fine and popular perfume is obtained. Violets are cultivated in southern France.

Essence of Violets.

Violet pomade	oz.	16
Alcohol deodorized	q. s. or "	16

Proceed as with cassie essence.

VITIVERT OR KUS KUS (ANDROPOGON MURICATUS).

Is the rhizome of an Indian grass.

Spirits of Vitivert.

Oil of vitivert	drops	30
Deodorized alcohol	oz.	4

YLANG OR IHLANG (CANANGA ODORATA).

This plant is found in the Philippines and the islands of the Indian Archipelago. The oil is obtained by distilling the flowers. The perfume is very characteristic and lasting.

Spirit of Ylang.

Ylang oil	drachms	3
Deodorized alcohol	oz.	16

In the following formulas, if the perfumes are too expensive, the ambergris can be omitted and civet substituted, except in extract of ambergris. The musk can also be reduced in strength one-half, and still yield satisfactory results. In all cases secure the best goods, regardless of price. In perfumes, as well as in medicines, quality is of the first importance. When the perfumes are mixed they should be frequently agitated, and allowed to stand two or three weeks before filtering.

Age improves all perfumes, if kept in a moderate atmosphere, and in a dark place.

* A paper read before the Michigan Pharmaceutical Association, Detroit, 1884.—*The Druggist.*

AMOUNT AND COST OF MATERIAL REQUIRED.

Quotations here given were received by me July 24, 1884.

Deodorized alcohol	5	gal.	@ $ 2.40	$12 00
Ambergris, best gray	½	oz.	@ 27.00	3.38
Oil of Bitter Almond	½	"	@ .50	.25
Oil of Bergamot	4	"	@ .10	.40
Gum Benzoin	4	"	@ .03	.12
Cassie Pomade	1	lb.		2.25
Civet	¼	oz.	@ 2.25	.56
Oil of Cloves	1	"		.07
" Citronella	1	"		.06
Jasmine Pomade	1	lb.		2.25
Oil of Lemon	4	oz.	@ 1.40 per lb.	.35
" " Grass	1	"		.10
" Lavender (Mitcham)	1	"		2.50
Musk (best grain)	¼	"	@ 30.00	7.50
Oil of Neroli petale	1	"		3 50
" " petit grain	1	"		.50
" Orange	4	"	@ .11	.44
Orange Flower Pomade	1	lb.		2.25
Oil of Pimento	½	oz.	@ .24	.12
" Patchouly	¼	"	@ 1.00	.25
" Rose	1	"		9.00
" " Geranium	1	"		.50
Rose Pomade	1	lb.		2.25
Oil of Rosemary	2	oz.	@ .10	.20
" Santal	1	"		.50
Tuberose Pomade	1	lb.		2.25
Tonka Beans	8	oz.	2.00 per lb.	1.00
Vanilla "	4	"	10.00 "	2.50
Violet Pomade	1	lb.		3.00
Oil of Vitivert	½	dr.	@ 1.50	.75
" Ylang	½	oz.	@ 8.00	4.00
Total				$64.90

1. AMBERGRIS EXTRACT.

Spirit of rose	oz. 3
Tincture of ambergris	" 8
" " musk	" 4
" " vanilla	" 1

Cost $6.07 per pint. Where permanence is desired, this can be recommended.

2. ESS. BOUQUET.

Spirit of rose	oz. 8
Tincture of ambergris	" 1
" " orris	" 1
Essence of cassie	" 1
Oil of bergamot	drops 30
" lemon	" 60
" neroli petale	" 15
Deodorized alcohol	oz. 5

Cost $2.18.

3. FRANGIPANNI.

Tincture of musk	oz. 5
" " civet	drachms 4
" " orris root	oz. 3
Essence of orange flowers	" 3
" " tuberose	" 3
Spirit of vitivert	" 1
Oil of santal	drops 60
" neroli petale	" 60
" rose	" 120
" " geranium	" 60

Cost $6.50 per pint. Where there is a demand for something lasting, regardless of price, this will prove satisfactory.

4. ROSE GERANIUM EXTRACT.

Oil of rose geranium	oz. 1
Deodorized alcohol	" 15

Cost 80 cents per pint.

5. HELIOTROPE.

Tincture of vanilla	oz. 8
" " ambergris	" 1
" " civet	" 1
Spirit of rose	" 3
Essence of rose	" 3
Oil of bitter almond	drops 5

Cost $2.10 per pint.

6. HONEYSUCKLE.

Essence of rose	oz. 4
" " violet	" 4
" " tuberose	" 4
Tincture of vanilla	" 1
" " tolu	" 1
" " musk	" 1
Oil of neroli petale	drops 3
" bitter almond	" 2
Deodorized alcohol	oz. 1

Cost $2.80 per pint.

7. JOCKEY CLUB.

Spirit of rose	oz. 4
Essence of rose	" 1
" " tuberose	" 4
" " cassie	" 2
" " jasmine	" 1
" " orange flowers	" 1
Tincture of civet	" 2
" " musk	" 1

Cost $2.50 per pint.

8. LAVENDER EXTRACT.

Oil of lavender (Mitcham)	drachms 4
Essence of rose	oz. 2
Deodorized alcohol	" 14

Cost $2.30 per pint. By using the common oil of lavender flowers the cost will be about $1.20.

9. LILY OF THE VALLEY OR WHITE POND LILY.

Essence of tuberose	oz. 8
" " jasmine	" 1
" " orange flowers	" 1
" " cassie	" 2
" " rose	" 2
Spirit of rose	" 1
Tincture of vanilla	" 1
Oil bitter almonds	drops 2

Cost $2.50 per pint.

10. MILLEFLEURS (THOUSAND FLOWERS).

Spirit of rose	oz. 3
Essence of rose	" 1
" " jasmine	" 4
" orange flowers	" 2
" of cassie	" 2
Tincture of orris	" 2
" " tonka	drachms 4
" " ambergris	" 4
" " musk	" 4
Oil bitter almonds	drops 3
" of neroli petale	" 3
" " cloves	" 3
" " bergamot	" 120

Cost $2.55 per pint.

11. MUSK.

Tincture of musk	oz. 11
Spirit of rose	" 4
Tincture of civet	" 1

Cost $5.90 per pint. This is rather a high priced article, but the tincture of musk can be reduced one-half with alcohol and still yield a satisfactory result. The cost will then be $3.25.

12. NEW MOWN HAY.

Tincture of tonka	oz. 6
Spirit of rose	" 2
Essence of rose	" 2
" " jasmine	" 2
Oil of neroli petale	drops 10
" rose geranium	" 60
Deodorized alcohol	oz. 4

Cost $1.65 per pint.

13. NIGHT-BLOOMING CEREUS.

Spirit of rose	oz. 4
Essence of jasmine	" 4
Tincture of tonka	" 2
" " civet	" 2
" " benzoin	" 4

Cost $1.65 per pint.

14. ORANGE FLOWER EXTRACT.

Essence of orange flowers	oz. 12
" " cassie	" 2
Tincture of musk	" 2

Cost $3.20 per pint.

15. PATCHOULY.

Oil of patchouly	drops 75
" rose	" 15
Deodorized alcohol	oz. 16

Cost 75 cents per pint.

16. SWEET PEA.

Essence of tuberose	oz. 5
" " orange flower	" 5
" " rose	" 5
Tincture of tonka	" 1

Cost $2.50 per pint.

17. CLOVE PINK.

Essence of rose	oz. 6
" " cassie	" 4
Spirit orange flower	" 4
Tincture of vanilla	" 2
Oil of cloves	drops 10

Cost $2.40 per pint.

18. RONDOLETIA.

Tincture of musk	drachms 4
" " ambergris	" 4
" " vanilla	" 4
Oil of bergamot	" 1
" lavender (Mitcham)	" 2
" cloves	" 1
" rose	drops 30
Deodorized alcohol	oz. 14

Cost $3 per pint. With common oil of lavender flowers it will cost $1.60.

19. ROSE.

White Rose (*No.* 1).

Spirit of rose	oz. 8
Essence of rose	" 3
" " jasmine	" 4
Extract of patchouly	" 1

Cost $2.50 per pint.

20. *White Rose* (*No.* 2).

Oil of rose	drachms 2
" " geranium	drops 30
Essence of rose	oz. 4
Deodorized alcohol	" 16
Essence of jasmine	" 2
Tincture of musk	" 1
" " ambergris	" 1

Cost $3 per pint. Extract of white rose is a general favorite, and cannot be recommended too highly.

21. MOSS ROSE.

Spirit of rose	oz. 9
Essence of orange flowers	" 3
" " rose	" 2
Tincture of civet	" 1
" " musk	" 1

Cost $2.85 per pint.

22. TEA ROSE.

Essence of rose	oz. 4
Spirit " "	" 8
" " santal	" 2
Essence of orange flowers	" 1
Tincture of orris	" 1
Oil of rose geranium	drops 20

Cost $2.20 per pint.

23. SPRING FLOWERS.

Essence of rose	oz. 7
" " violet	" 6
Oil of bergamot	drachm 1
Spirit of rose	oz. 1
Tincture of ambergris	" 1
Essence of cassie	" 1

Cost $2.95 per pint.

24. TUBEROSE EXTRACT.

Essence of tuberose	oz. 15
Tincture of ambergris	" 1

Cost $2.85 per pint.

25. UPPER TEN.

Tincture of vanilla	oz. 4
" " ambergris	" 3
" " orris	" 3
Spirit of rose	" 3
Essence of orange flowers	" 3
Oil of bergamot	drops 90
" lemon	" 15

Cost $2.75 per pint.

26. VERBENA.

Oil of lemon grass	drops 50
" lemon	" 320
" neroli petale	" 20
" orange	" 100
Essence of orange flowers	oz. 3
" " tuberose	" 3
Spirit of rose	" 3
Deodorized alcohol	" 6

Cost $1.90 per pint.

27. VERBENA (NO. 2).

Oil of lemon grass	drachms 3
" lemon	" 4
" orange	drops 30
Deodorized alcohol	oz. 15

Cost 60 cents per pint.

28. VIOLET.

Essence of violets	oz. 11
" " cassie	" 2
Tincture of musk	" 1
" " orris	" 2

Cost $3 per pint.

29. VIOLET (NO. 2).

Essence of cassie	oz. 6
" " rose	" 3
" " tuberose	" 3
Tincture of orris	" 3
Spirit of bitter almonds	" 1

Cost $2.05 per pint.

30. WOOD VIOLET.

Extract of violets, No. 2	oz. 16
Oil of bitter almonds	drops 15

Cost $2.10 per pint.

31. YLANG YLANG.

Spirit of ylang	oz. 8
" " rose	" 4
Essence of jasmine	" 3
Tincture of civet	" 2

Cost $2.70 per pint. This is my favorite; it combines fragrance and lasting qualities at a moderate price.

32. WHITE LILAC.

Essence of tuberose	oz. 12
" " orange flowers	" 3
Tincture of civet	drachms 4
Spirit of ylang	" 4
Oil of bitter almonds	drops 3

Cost $2.50 per pint.

To those who may wish to carry their study in perfumes and kindred arts further, I can recommend the works of G. W. S. Piesse, D. I. Cristiani, John H. Snively, and W. Saunders' article on perfumes read at the session of the twenty-fourth annual meeting of the American Pharmaceutical Association.

ON THE BOILING-POINT OF HYDROGEN.

By EDMUND J. MILLS, D.Sc., F.R.S.

IN a recent memoir (*Phil. Mag.*, [5] xvii., 173) I showed that the boiling-point y of any member of a homologous series is related as follows to the coefficient x of C in its formula—

$$y = \frac{\beta(x-c)}{1+\gamma(x-c)},$$

c being the value of x to which zero Centigrade corresponds, and β γ constants depending on pressure and other conditions. Thus, the equation to the series of olefines in which x is even is—

$$y = \frac{40{\cdot}709\ (x-4{\cdot}228)}{1+0{\cdot}060123\ (x-4{\cdot}228)}.$$

Putting $x = 2$, $y = -104{\cdot}7°$, the calculated boiling-point, at the ordinary pressure, of common olefiant gas. Olzewski (*Comptes Rendus*, xcix., 133) has since found that olefiant gas boils at −103° under a pressure of 750 mm.

The satisfactory character of this result has induced me to calculate the boiling-point of hydrogen. It is perfectly clear, and has been long since supposed, that hydrogen (H_2) is, or may be, the "origin" of the series of paraffins, $C\ H_{2n+2}$. In the memoir referred to, the boiling-points of the normal paraffins were discussed, and equations found for them. There are in all four series to deal with, viz., the even and odd series under ordinary pressure, and the same series under a pressure of 15 mm., the latter having been worked out by Kraffts.

The equation for the even series is—

$$y = \frac{39{\cdot}315\ (x-3{\cdot}94)}{1+0{\cdot}070753\ (x-3{\cdot}94)},$$

and for the odd series—

$$y = \frac{38{\cdot}992\ (x-3{\cdot}92)}{1+0{\cdot}070564\ (x-3{\cdot}92)}.$$

Under 15 mm., the equation to the even series is—

$$y = \frac{23{\cdot}154\ (x-7{\cdot}1)}{1+0{\cdot}085484\ (x-7{\cdot}1)},$$

and to the odd series—

$$y = \frac{21{\cdot}685\ (x-6{\cdot}77)}{1+0{\cdot}080437\ (x-6{\cdot}77)}.$$

When in each of these four equations we put $x = 0$, the results are:

	y.
Even	−214·77
Odd	211·29
Even (15 mm.)	219·76
Odd (15 mm.)	184·91

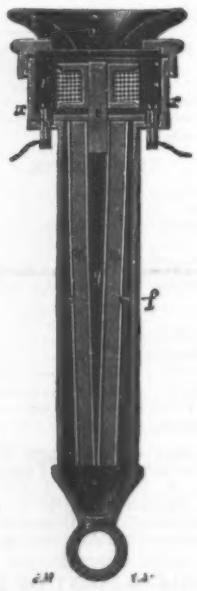
The discordance between the results for the odd series, as compared with those of the even series, shows that hydrogen is certainly not the origin of the odd series of paraffins. The two results, however, for the even series amply support each other, and show the boiling-point of hydrogen to be about −215° C.

Messrs. Wroblewski and Olzewski are understood to be separately engaged in the investigation of this subject. According to the former (*Comptes Rendus*, xcviii., 982, oxygen and nitrogen boil respectively at −184° and −193° under the ordinary pressure, and the temperature at which hydrogen liquefies is not greatly distant from −184°. These temperatures were measured thermo-electrically. Olzewski, who uses a hydrogen thermometer, has also liquefied hydrogen, and alleges that he has measured a temperature of −213° C. (*Ibid.*, xcix., 134.)

The question will probably be settled at an early date; but it is clear that the experimental number is not likely to differ greatly from −215° C.—*Chemical News.*

NEUMAYER'S TELEPHONE.

IN the central telephone office at Munich the Ader transmitter is employed, and the receivers are those of Mr. A. Neumayer. One of the latter apparatus is shown in the annexed figure. The magnet consists of five small bars, *m*, made of the best quality of English steel. In order to obtain as great a magnetic mobility as possible in the pole facing the vibrating disk, Mr. Neumayer employs a bundle of extremely fine wire, *e*. Toward its center this latter is soldered to a brass socket, and the lower half is intimately connected with magnetized rods, *m*. The other half serves as a support for the bobbin, whose wire is 0·11 mm. in diameter and has a resistance in general of 100 ohms.



NEUMAYER'S TELEPHONE.

In order to prevent those variations in distance between the diaphragm and pole which are a consequence of variations in temperature, the brass plate soldered to the bundle, *e*, is screwed to the box, *x*, that carries the vibrating disk. This box is of brass, and the diaphragm, which is 0·3 mm. in thickness, rests upon the top of it. The magnetized bars, *m*, are held in a brass ring, *f*, which is provided with a corresponding number of recesses.—*La Lumiere Electrique.*

ELECTRICITY'S DEADLY WORK.

A SHOCKING tragedy occurred on Sunday night in the Zocalo, where the beautiful concert pavilion has been erected for the festival of All Saints' and All Souls' Days. It was a case of peculiar interest. A man known as Pantaleon Estrada, a worker in guitars, tying a stone to the end of an ordinary wire, threw it over the electric wire. Estrada immediately fell dead in his tracks. The contact of the two wires killed him. A policeman standing by and a street car conductor had much of their clothing burned off, and were themselves so seriously injured that their lives tremble in the balance. The electric current affected others also more or less. The scene succeeding the tragedy was demoralizing. For a moment the dumb terror of seeing strong men totter and fall, as if struck by some invisible hand, held the crowd spellbound. Succeeding the terrorized apathy came a wild rush for life. Fortunately, exits were plentiful, and to that was due the fact that many were not stamped to death.

John Herbert of the electric light company mounted a ladder, with a silk handkerchief in hand, to remove the wire thrown by the unfortunate Estrada. The rain was falling heavily at the time, but he did not notice that the handkerchief was becoming damp. He applied it to the wire to remove it, and received himself a severe shock that threw him from the ladder. Falling to the stone pavement his head was cut open. He will recover, however. The police believe that Estrada represents a gang of pickpockets and thieves; that his object in throwing the wire was to extinguish the electric lights and give his pals a chance to operate. Whether that was so or not is not known, for he who could have told has had his lips burned to silence.

ELECTRICITY AS A MOTOR.

PROF. MOSES G. FARMER, in a recent letter to Mr. C. W. Field, gives the following interesting historical information:

Now that the application of electricity to the elevated roads is agitated, it occurs to me that it may be interesting to glance at some of the steps in the progress of discovery and invention which made electro-locomotion possible in 1850, and practicable in 1883-4. It was not until 1819-20 that Oersted, of Copenhagen, discovered that, if a wire carried a current of electricity from south to north over a magnetic needle, it caused the north end of the needle to be deflected toward the west, and also, if the current passed from north to south under the needle, the deflection of the north end of the needle was still toward the west.

It was not long before Schweiger carried the wire and current several times over and under the needle, and thus invented the galvanometer. Before 1826 Sturgeon had wound a wire several times around a bar of soft iron, and, when a current of electricity was sent through the coiled wire spiral, it made a temporary magnet of the iron bar, which magnetism remained as long as the current was flowing. Soon after, as early as 1831, Faraday discovered the principal facts of magneto-electric induction, and thus made the magneto-electric machine possible in the hands of Pixii in 1832. The Daniell's and the Grove's batteries soon after appeared, and in 1839 Jacobi, at St. Petersburg, constructed a boat, which he propelled upon the River Neva with a two horse-power electro-magnetic engine, actuated by a Grove battery, which had in it twenty square feet of platinum surface.

In 1840 Davenport and Cook, of Vermont, constructed a walking-beam engine, with which they drove a printing press, using a zinc and copper battery, with a solution of blue vitriol as the exciting liquid.

In 1842 Davidson, of Scotland, constructed a five-ton electric locomotive, which he propelled at the rate of four miles per hour with seventy-eight pairs of zinc and iron in sulphuric acid solution, the plates being thirteen inches square.

In 1844 Channing conceived the idea of substituting an electro-magnet in place of the permanent steel magnet in the magneto-electric machine of Pixii, and the further idea of using this electro-magneto electric machine to excite the field magnets of a still larger electro-magneto electric machine.

(This idea was subsequently, in 1863-6, further elaborated by Henry Wilde, of Manchester, England.)

In 1847 I constructed and exhibited in public an electro-magnetic locomotive, and with forty-eight pint-cup cells of Grove nitric acid battery drew a little car carrying two passengers on a track a foot and a half wide.

In 1850 Page, of Washington, constructed an electro-magnetic engine of sixteen horse-power, and with a hundred cells of Grove nitric acid battery, each having platinum plates eleven inches square, he propelled a car carrying a dozen or more passengers on the Washington and Baltimore Railroad at the rate of nineteen miles per hour.

In 1851 Thomas Hall, of Boston (then at work for Daniel Davis), constructed, and later exhibited at the Charitable Mechanics' Fair in Boston, a small electric locomotive which took its current from a stationary battery by means of the rails and wheel, as the following extract from a letter written to me by him, November 25, will show: "In the year 1851, when I was at work for Daniel Davis, I made a small electric locomotive, which ran on a straight track about twenty feet long. The wheels were insulated, and the electricity was conveyed to the engine by means of the rails from two Grove batteries. The cut-off was in the engine, and worked automatically or by hand, so that when the engine reached the end of the track the switch reversed the engine, and it went back to the starting point. In 1860 I exhibited in the Mechanics' Fair a small locomotive called the Volta, very finely made and finished, which ran on a circular track about eight feet in diameter. The current was conducted to the insulated wheels from two Grove batteries by means of the rails. I have a part of one of these engines on hand now, and photographs of the Volta; also woodcuts of the first ones, which were published in a catalogue between 1851 and 1860."

I asked Mr. Hall's permission to publish his letter, and in reply he says: "Shall be glad to have you publish the facts as I have stated them to you, and shall be obliged to you for doing it. You know they are facts as well as I do."

These four engines, therefore, of Davidson, Farmer, Page, and Hall could be started and stopped, sent forward or backward, at the pleasure of the engineer.

In 1859 I conceived of the self-exciting dynamo, which I constructed in 1866, and which was also conceived of by Wheatstone, Siemens, and Ladd in 1867 and by Gramme in 1871, so that by 1871 cheap electricity became possible, and nothing more was needed except to substitute the dynamo machine for the galvanic battery to make electro-locomotion both possible and cheap, and yet the invention slumbers on for a decade or more.

Now, in 1884, a host of inventors, by simply substituting the now well-known dynamo for the more expensive and troublesome acid battery, appear to be just on the eve of bringing to blossom and fruitage those buds of promise after their long forty years of germination, because there was then no demand, no elevated roads, and so they came not forth.

There are two principal methods of propelling an electric locomotive: 1st. The engine carries its source of electricity, such as a galvanic battery, as did Davidson's, Farmer's, and Page's. 2d. It is picked up from a stationary source by means of the wheels and rails, as did Hall's.

In the later days, since the advent of the storage battery, the supply of electricity can be economically carried on a tender, and it is worthy of very patient and long experimental inquiry, which method is the cheaper—to lay a third rail to carry the current to the locomotive, or to charge the storage battery, place it on a tender, and attach it to the locomotive.

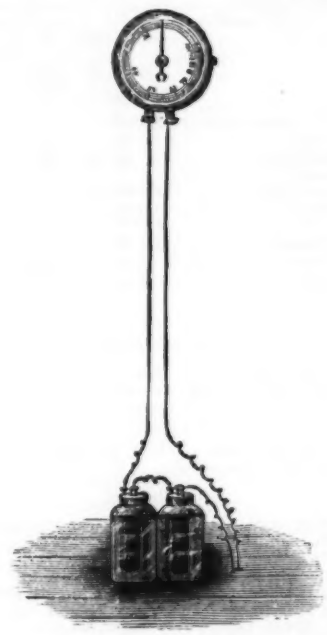
BY the addition of ten parts of collodion to fifteen of creosote (says the *Revue de Therap.*) a sort of jelly is obtained which is more convenient to apply to decayed teeth than is creosote in its liquid form.

ELECTRICAL SPEED INDICATORS.

OUR illustrations represent Messrs. Farquharson and Lane's patent electrical speed indicator, specially designed for use on board ship for indicating the number of revolutions per minute at which an engine is running. Of course there are a number of other uses to which this instrument may be applied, such as checking the speed of dynamos, etc., which are self-evident.

The design of the instrument is certainly novel, and, from its simplicity, compactness, and reliability, should commend itself for these purposes.

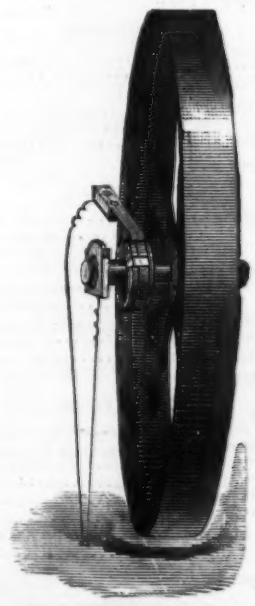
A small commutator is fixed upon the shaft of the engine or other piece of machinery, the speed of which it is required to note, and upon this a contact brush is made to bear. The commutator is so arranged that at each revolution of the shaft one contact only for an



instant is made; the shaft is in connection with one pole of a battery, the other pole being connected to earth. The contact brush is joined by means of an insulated wire to the indicator, and from thence to earth.

It is evident that with a shaft traveling a given number of revolutions per minute, the interval of time between each completion of the circuit by the revolution of the commutator against the brush would be a constant interval, its length being in accordance with the speeds.

The indicator is so constructed that by pressing a button on the side of the instrument the circuit is complete the instant the commutator on the shaft has come in contact with the rubbing brush. By means of an electro-magnet placed within the indicator, at the instant the circuit is completed the pointer is released and continues to move around the dial until the commutator on the shaft has again come in contact with the



brush and completed the circuit a second time; at this moment the pointer will be instantaneously stopped.

The rate at which the hand travels being constant, it follows that the interval of time taken for the hand to move would be the same as that taken for one revolution of the shaft, and if, therefore, instead of marking the number of seconds or parts of seconds upon the dial of the instrument, the speed is marked corresponding to that interval of time, it follows that the speed of the shaft may be indicated. For instance, supposing a shaft to be traveling at the rate of 60 revolutions per minute, it would take one second to each revolution. Now the pointer in this space of time would have traveled a certain distance around the dial; if at this point the figure 60 is marked, it will represent the number of revolutions of the shaft per

minute. The other speeds of course would also be marked upon the dial, in each case corresponding to the time taken by the shaft to complete one revolution.

In order that the rate at which the pointer travels may be perfectly uniform, it is, previous to each observation, replaced to its zero position, the mechanism being so arranged that the replacing of the pointer to zero winds up the spring actuating the mechanism of the instrument, and thus insures a constant motive power.

The mechanism of the indicator has been very carefully designed so as to insure great accuracy in its action, and at the same time it is simple in its construction and not liable to get out of order.

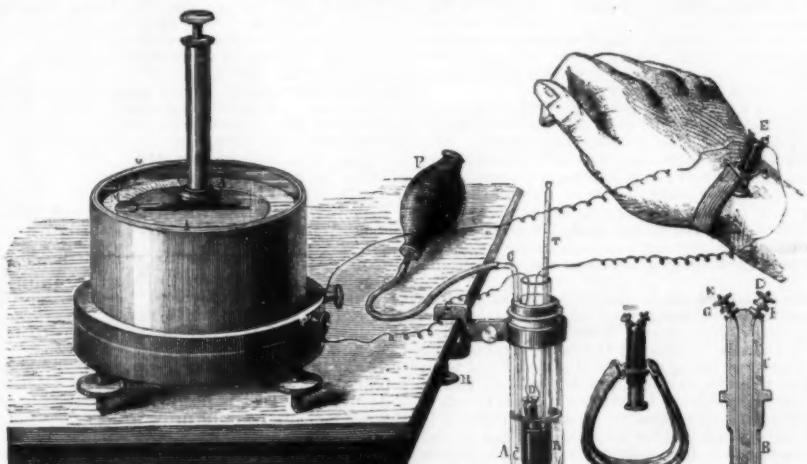
A further point we would mention is that from the construction of the instrument the revolutions of the shaft may be read off by sound as well as by the indication on the dial. This, under many circumstances, would be found an advantage. By this means a thorough check can be kept upon the adjustment of the indicator.

A number of these indicators may be connected by a single wire in different parts of a factory or steamship, the same battery used for one being sufficient to work the whole of them. Again, the distance at which the indicator may be placed from the shaft is, within reasonable limits, immaterial. The battery will only be in action at the moment the indicator is being used, so that the battery power expended would be in direct proportion to the number of readings taken. It is evident, therefore, that for a variety of purposes this indicator would be very applicable, such as indicating the speed of dynamos, engines of steamships, etc., etc., and we feel sure that it only requires to be thoroughly known to be largely employed.—*Elec. Review.*

ON THE ELECTRIC THERMOMETER IN MEDICINE.

WHEN the temperature of a natural cavity, such as the mouth, armpit, etc., is to be taken, what is called a *medical* thermometer gives sufficiently accurate data. The same is not the case, however, when we desire to know the temperature of a surface, or of a given point.

For a long time past the electric thermometer has



REDARD'S THERMO-ELECTRIC APPARATUS.

been thought of, and this apparatus has rendered immense service in physiological laboratories. It is but just to recall the fact that this mode of determining temperatures, and its application to physiology, are due to Mr. Becquerel, senior. Among the best known apparatus are those of Hankel, Helmholtz, and Claude Bernard. These apparatus, which are excellent in physiology, cannot be used in clinics, since they are bulky, of complicated mechanism, and difficult to maneuver, and the accuracy of the observations requires a very correct galvanometer placed in a stationary position, and the reading of this must be done by means of a mirror and spy glass.

It became necessary, then, in order to employ the thermo-electric method for ascertaining temperatures in medicine, to modify the apparatus, and, while preserving their accuracy, to simplify them and render them portable and of easy management. This is what a certain number of physicians have endeavored to do in recent years. Two apparatus especially seem to us worthy of being made known, that of Mr. Lombard, of London, and that of Mr. Redard.

Mr. Lombard compares the temperature of two points of the body by means of two Melloni piles of special construction that act upon a Thomson mirror provided with a reflecting scale. A system of resistances and commutators interposed between the piles and the galvanometer permits of equalizing the currents produced by the two piles when they are at the same temperature, and of afterward regulating the sensitiveness of the apparatus according to requirements. This apparatus, which has already given very accurate results in Mr. Lombard's hands, is still too complicated, and especially is not easily transportable.

The problem appears to us to have been solved in a more practical way in the apparatus invented by Mr. Redard, and which is a modification of the electric thermometer employed by Dr. Becquerel for determining temperatures at different depths of the soil. It consists (see figure) of the following parts:

1. Of *thermo-electric plates* formed by soldering two metals, and of a special arrangement designed to facilitate the application to cutaneous surfaces. The metals selected for this purpose are iron and German silver, which give great sensitiveness. At A there is an iron disk, which at B is connected with a rubber sleeve, C. The enlarged part of the disk is designed for putting it in connection with the part to be explored. In the interior of the rubber sleeve there are two wires, one (D) of iron and the other (E) of German silver, which are each fixed in apertures in the iron disk, but do not traverse the latter. At G and F are two nuts (one of iron and the other of German silver), which are designed for connecting the thermo-electric plates with the wires of the circuit. The solderings of these plates are *concentric*, and the method adopted for their construction is the one indicated by Dr. D'Arsonval. The thermo-electric plates take an equal temperature very quickly. The application to the part to be explored is facilitated by means of the mode of fixation, shown in the figure at K.

2. The *galvanometer* differs from ordinary ones in its form and its small size. It consists of a sort of copper drum, G, covered with a plane glass which allows the divisions of the scale to be seen. At the zero point there is a mirror that is designed to allow of an accurate reading of that division. The galvanometer wire is short and coarse, and one millimeter in diameter. The astatic system which forms the needles is very light, and is suspended by a cocoon fiber contained in a copper sheath which is provided with a screw that permits of raising or lowering the needle. The form of the galvanometer allows of its being easily carried. The sensitiveness of the instrument is very great; for example, for one degree of difference in temperature between the two solderings there is obtained a deflection of from 20 to 22 degrees of the galvanometer, and, as it is easy to read ½ a degree of the divisions of the graduated circle, we get the temperature to within one-fortieth.

3. Two German silver wires and an iron one form a circuit which connects the plates with the galvanometer. The iron wire extends from the iron nut, F, of one plate to the similar nut of the second soldering, and the two German silver ones are affixed to the two German silver nuts of the plates, and end at the terminals of the galvanometer. The iron wire, which is 1 mm. in diameter, is 30 cm. in length, and the German silver ones are 1 mm. in diameter and 60 cm. in length. Mr. Redard uses an iron wire circuit 1 mm. in diameter which joins the iron pieces of the two couples. The German silver pieces are soldered to two wires of the same material, which are connected with two copper ones that run to the galvanometer. In this way the resistance of the circuit is diminished and the sensitiveness increased. The solderings of the German silver wires to the copper ones are insulated and surrounded with the same envelope, so that they are always at the same temperature, and no error is to be feared.

These first pieces of the apparatus permit of making researches in comparative local thermometry; thus, knowing that Becquerel has demonstrated that when the two solderings are at the same temperature the galvanometer needle stands at zero, we may, by placing the two plates upon symmetrical regions, find the warmer or colder side from the direction of the deflection. If we obtain a deflection of 20 degrees, we know, from the graduation of the galvanometer, that there is a difference of one degree between the two regions explored. We may thus very quickly learn with sufficient accuracy whether there exist differences of temperature of $\frac{5}{10}$, 1 degree, and 1½ degrees. This method of comparative thermometry by means of the apparatus gives very sure and quick indications, and suffices in a large number of cases.

In order to obtain the temperature of a surface in thermometric figures, the apparatus is arranged as follows: The principle adopted is that of the Becquerel apparatus for determining temperatures at different depths of the earth and at different heights of the atmosphere. Being given a thermo-electric circuit composed, for example, of wires, one of them of copper, the other of iron, soldered together at their extremities and covered with gutta-percha throughout the rest of their length, if we interpose a galvanometer in the copper wire the current will be null, and the galvanometer needle will stand at zero every time the two solderings are at the same temperature. If, then, we place one of the solderings in the medium that we desire to study, and the other in a medium whose temperature may be readily varied, and in which there is likewise a sensitive and accurate thermometer, it will only be necessary, in order to know the temperature of the other medium, to cool or heat the second until the galvanometer needle comes to zero, and to then read the thermometer.

When the two thermo-electric plates are at the same temperature, the needle will remain at zero.

The circuit employed is the same as the one described above. The medium with variable temperature is mercury contained in the tube, B, which is itself suspended by means of a cork in another and wider tube, A, partially filled with alcohol. The tube, A, is fixed very simply to a table by means of a support, K. The cork is traversed by a tube, C, which runs to the bottom of the tube, A, and is connected at its upper part with an atomizer built, P. In this way, by forcing a few bubbles of air into the alcohol, quite a notable cooling may be effected; when it is a question of reheating, we plunge the tube, A, for a few seconds into water at 50°.

In practice, we proceed in the following manner: Say we want to ascertain the cutaneous temperature of the back of the hand. A thermo-electric plate is applied, at E, to the hand, and assumes an equal temperature. The second, D, dips into the mass of mercury, whose temperature is indicated by the thermometer, T. The galvanometer is set at zero, and the circuit is closed. If the two plates are at the same temperature, there will be no deflection, and it will suffice to read the thermometer in order to have the temperature sought. If the plate, E, is warmer than D, a deflection will occur. Then the tube, A, is warmed, and the needle returns to zero. When it is stationary, the thermometer is read. If, on the contrary, D is warmer than E, a deflection will occur in the opposite direction. Then the tube is slowly cooled by a few bubbles of air, and when the needle comes back to zero and remains stationary the thermometer is read and the temperature is obtained.

The heating and cooling must be done slowly, so that the solderings and constituent parts may have time to come to an equilibrium as regards temperature. Besides, it is necessary before beginning the experiment to raise the soldering that dips into the mercury to a temperature near that which we desire to observe, and to afterward allow it to cool slowly, according as the temperature of the explored region is higher or lower. It is necessary to wait until the thermometer is fixed and the needle stands at zero for a minute or two.

The apparatus, which is constructed by Mr. Carpentier, is contained in a box of very small bulk, and is thus very portable.—*Dr. E. Renault, in Science et Nature.*

SANITATION.*

By THOMAS WILLIAMS.

THE scope of the subject entitled Sanitation possesses a universal and intimate bearing in connection with the existence and well-being of all living things.

The term sanitation may be applied to conditions occurring in nature, or to such circumstances as are brought into existence by mankind.

Sanitation includes a great number of duties ministering to the wants, safety, and comfort of the living, and the decent disposal of the dead. Arising from the practice of sanitation we have the branch of knowledge known as sanitary economy and sanitary science.

Necessity compels, owing to the vastness of the subject, that we should limit the communication that I have the honor to bring before you for discussion this evening to one department in sanitation, namely, the air we breathe.

We are aware that there is an enormous supply of air around us; approximately there is 15 lb. weight of air on every square inch of the earth's surface; it is also known that it is the principal article consumed, as regards quantity, by the animal economy. It is, therefore, of vital importance that we should have a pure atmosphere, as under such conditions we should be practically sure of the purity and wholesomeness of all other requisites, the preservation and storage of water and food would be easy, and the maintenance of health simple. Scientific chemists have pointed out that in the main the natural component parts of common air are three substances, namely, oxygen gas, nitrogen gas, and water vapor. It is known that there are some localities on the earth's surface where the air is so impure that it cannot be breathed, and in some mines, manufactories, etc., without ventilation, and a large admixture of common air, work-people could not exist, and the health of the individual is ruined even in breathing the mixture. In towns, again, ordinary air is unknown, and as a result of the degree of its pollution thousands of lives are injured and lost annually. It is almost impossible to ventilate the narrow alleys and courts of our large cities, as, unfortunately, the air in the street is no fresher than that inside the house. It needs little observation to discern the sources, and, to some extent, form an estimate of the quantity of the pollution which the air receives, especially in a city like Liverpool. For if an observer views the air of the town from any elevated position, he will see the ten thousand chimneys pouring down their contents on to the inhabitants below, and again in walking the streets you have every few yards the sewer ventilators discharging their foul emanations.

The impurities are various in their nature, and include bodies or gases invisible and inodorous, odorous invisible bodies, odorous visible bodies, such as coal smoke and flue dust, etc., organic exhalations bodies, microscopic organic germs. It will be unnecessary to dwell on the production and injurious nature of each individual substance enumerated above; for our purpose we will classify them into two groups, namely, smoke or chimney exhalations and sewer gas. It will, however, be as well for us before proceeding to examine the sanitary arrangements of the present day to take a glance back as far as we have any record, and endeavor to trace the progress from the earliest period.

The first records of any laws upon the subject of health are the Mosaic, and in studying them over, although at a distance of three thousand five hundred years, we cannot but be struck with the fact of how little we have advanced, or, perhaps more correctly, how those ideas have guided succeeding generations, especially in diseases of an infectious character, such as leprosy, those afflicted being placed in quarantine for seven days, and if at the expiration of that period the disease had not spread, the priest pronounced them clean, and after offering certain sacrifices the sufferers were again allowed to mix with their brethren; but if at the end of seven days the leprosy continued, the poor unfortunate was banished the camp. Wherever the houses became infected with leprosy, the infected part was to be taken out and cast into an unclean place without the city, new stones and plaster were to be used in their place; if, after this repairing, the disease again showed itself, the house was to be razed to the ground and the stones cast into an unclean place outside the city. If, however, the plague did not show itself after the repairing, the walls were sprinkled with hyssop and cedar and blood, partly, doubtless, as a

* Read at an evening meeting of the Liverpool Chemists' Association, October 23, 1884.

disinfectant, and partly as a religious ceremony. The laws of quarantine are practically the same to-day as they were three thousand years ago, and the separation of the infected from those that are free, which seems to be dawning upon the authorities as desirable, but by no means essential, was very stringent, any failure upon the part of the infected being punishable with death.

We next find that the Italian tribes worshiped the pastoral goddess Pales, and were in the habit of calling down blessings for the fruitfulness and health of their flocks; but evidently at that date full reliance was not placed upon the blessings of the goddess, as they found it necessary or helpful for the health of their flocks to pass them through the fumes of sulphur. We also find that Ulysses was acquainted with the value of sulphur, as he used it for removing the smell arising from the dead bodies of the suitors for the hand of his wife after their massacre.

For many centuries little was done to prevent the spread of infectious diseases, the ravages of the plague decimating the world; and as the population increased the huddling together of the poorer classes always gave a foothold to any epidemic, as was so vividly witnessed by the plague in London, in 1665, when the deaths were over 100,000; and during the visitation of cholera to Europe in 1830 to 1834, the deaths in the Caucasus were 10,000 in a population of 16,000, and in one province of Russia the deaths were 31,000 in 54,000. In 1666, the year following the plague in London, came the great sanitary engineer, the fire, destroying the unhealthy and unsanitary rookeries where, during the previous year, the plague had held high festival. At the end of the eighteenth century some attention was paid to antiseptics: the list of those recommended, at any rate, gave sufficient for any one to choose from, but their value, in most instances, was very small, as the following list will show: alkalies and salts, gum resins, such as myrrh, assafœtida, etc., decoctions of Virginian snake root, pepper, ginger, saffron, sage, mint, valerian, rhubarb, senna, wormwood, celery, turnips, carrots, garlic, onions, cabbage, horseradish, and molasses. More attention was also paid to drainage of houses and streets. Wooden pipes, of which a specimen in oak 6 feet 6 inches long, 7½ inches square, and 3½ inches bore is shown at the Health Exhibition, taken from Hackett's Hotel, Piccadilly, London, and supposed to have been laid down about one hundred years ago, brick drains, wood troughs, and common tiles being used, generally having an outlet into a cesspool for all the matter that had not previously percolated through the wooden troughs and joints of the tiles, the heavier portion settling to the bottom and the liquid running over. The cesspool, being placed generally in a place not lending itself to easy access, was only cleared out when the stench became unbearable or some serious outbreak of disease drew attention to it. Following this period we come down to the visitation of cholera to this country in 1832, when the public mind was specially directed to improvements in sanitary matters. It is only, therefore, within the last fifty years that the subject of sanitation has had much attention paid to it; but during that period much work has been done under the Public Health Act and the separate Acts of Parliament for most of our large boroughs and local board districts. The engineer has been called in, vast waterworks have been formed, and water at high pressure is now obtainable in all our large towns and most of our smaller ones; thousands of miles of sewers and drains have been made; thousands of miles of streets have been paved with sets, and the parapets flagged; thousands of old houses, veritable dens of disease, have been swept away; time-honored graveyards have been closed and cemeteries opened, originally placed at some distance from the centers of our dense populations, but which now, unfortunately, with the rapid growth of our towns, are surrounded as much as the old churchyards were. The question of the disposal of our dead is a matter that will have to be faced, and let us hope that public opinion may be guided to the rational system of cremation. The great demand for sanitary work has called into the field inventors by the hundred, with their patent sockets, glazed earthenware pipes in place of the old wooden trough, stench traps and ventilators for the streets, patent water-closets by the score, etc., etc., so that the engineer of the day has had nice material to work with, and with it he has doubtless made a good show in our houses and left substantial work in our streets. But still, with all this skill and all these improvements, and the many millions of pounds sterling that have been spent and still are being spent to carry them out, the undeniable fact still remains that the death-rate of the kingdom is fully one-third greater than it should be, and that the general sanitary arrangements are provocative of disease instead of being preventive. Sir Robert Rawlinson, C.B., states that in Dublin and its vicinity there is not a single residence in a satisfactory condition; and in the metropolis it is stated, on the experience of sanitarians, that there are not five hundred houses properly and safely drained. You may go further, and say that there are not five hundred in the kingdom, and also that, to a great extent, the millions spent on the vast sewerage schemes have been literally, not figuratively, thrown into the gutter, and thence into the sewer; that in all these great and small schemes, whatever the object has been, the effect is to make sewer gas and poison the people, and that the first principles of sanitation have been openly and willfully neglected—"*the prevention of decomposition or fermentation.*"

What is the result of decomposition? Sewer gas and germ development. Sewer gas is formed of various bodies or component parts, as CO, CO_2, C_2H_2N, etc.; SO_2, SH_2. While the fermentation is going on, zymotic or development is caused. That is, pre-existing germs becoming active organisms by fermentation taking place, as Pasteur demonstrates, by atmospheric influence, "not upon its oxygen or any gaseous constituents, but upon minute particles suspended in it, which are germs of various low forms of existence." Professor Tyndall calculates that germs equal to the population of the world could be placed on four square inches, and that one million could be piled on the head of a pin. Among the interesting facts pointed out by Dr. Duclaux, in his valuable work on fermentation, the rapidity of development of some of the lower forms of life stands out in prominent array. Speaking of the development of certain germs (bacteria) he says Cohn "found that it would take two hours for two living organisms proceeding from segmentation in certain bacteria to attain the dimensions of the parent, and in their turn to multiply. Hence in three days the progeny of a single specimen if unhampered would number 4,772 billions. As it is about the thousandth of a millimeter in breadth and two in length, and as its density is about the same as that of water, 536 millions would be required to make the weight of a milligramme (about 0·015 of a grain English). It is then easy to calculate that the offspring of a single specimen would in twenty-four hours only weigh the fiftieth of a milligramme; but at the end of three days it would weigh 7,500 tons." Such figures show us, in truth, that we must cease to wonder at the rapid spread of diseases when these germs multiply and increase at such an alarming rate. We thus find that our tens of thousands of miles of sewers and drains are forcing-houses for germ development, the matter passing into the sewer. Commencing immediately to decompose, the sewers becoming one immense gas factory provided, as the law directs, with street ventilators which pour forth, both when we are asleep and when we wake, sewer gas laden with myriads of germs in a more or less active condition, ever ready and willing to attack the weak and ailing. The fatal results arising from this dissemination of sewer gas into our streets is indeed great, but can bear no comparison with the effects of sewer gas entering into our houses from water-closets, slopstones, etc. It is generally supposed that the water-traps attached to water-closets, etc., are a perfect seal against the back pressure of noxious vapors from the sewer; but we only have to think for one moment and the fallacy is apparent. The depth of water in ordinary traps is some six inches, and the atmospheric pressure being sufficient to balance a column of water of thirty-four feet, it is self-evident that an increase of pressure in the sewers of only three ounces per square inch would overcome the six inches of water in the trap, and that as at present arranged they are only a delusion and a snare. Mr. C. P. Cotton, Engineering Inspector of Sanitary Work in Ireland, in a valuable paper read at the Sanitary Congress at Dublin, states, "I have seen sewer gas pouring back through a sink into a house in one of the best parts of Dublin (indeed, my attention was attracted by the noise), owing to the filling of the low levels of the sewers by the tide." If further proof be needed that gas can overcome the water in the stench traps of houses, we have only to refer to the account of the correspondent of the *Daily News* in Naples, that in burning sulphur in the sewers to disinfect them the fumes entered the houses through the closets during the night, nearly suffocating the inmates, driving them out into the streets, where they aroused their neighbors and crying out that they were being poisoned intentionally.

Having proved that sewer gas is the result of decomposition, and that fermentation is the cause of germ development, and that the sewers are always fully charged with the death-dealing compound, and that the sewer and closet traps are inadequate to deal with the gas, the question comes, Is there any method or means by which decomposition can be hindered and sewers utilized, as originally intended, for the conveyance of sewage to a given point without the matter undergoing change? Many schemes have been devised.

The system of Mr. Shone is one that has many features to recommend it, being very superior to the present plan; it is in operation at Warrington and Eastbourne. The plan is to connect the house drains with the sewer, this sewer being connected at one end with a tank sunk to a depth to allow any desired fall in the sewer. When this tink is filled to a certain point, a float connected with the valve of an air compressor is opened and the sewage matter is ejected into a sealed pipe, and forced either into another tank at a higher elevation or direct, it may be, to a sewage farm several miles distant. The pressure of air employed is about 50 lb. to the square inch, and at an exhibition at Warrington to show the power, the sewage was ejected from a tank into the open air to the height of about 80 feet. The olfactory nerves were soon satisfied of its efficiency, and if further proof was wanted, the descent of the vile compound among the invited guests quickly decided the matter. The late Mr. Spence, of Manchester, whose personal friendship I had the honor of having for many years, suggested, many years ago, a system of atmospheric or gaseous sewerage, the idea being to connect the chimneys of the houses with the sewers, leading them to centralizing conduits converging to a point where an immense chimney, 600 feet high, would be erected to discharge the gases into the atmosphere, the ascensive power being obtained either from the retained heat of the gases, or if this was not sufficient, by the addition of artificial heat or a fan. Mr. Spence gave the figures for a chimney necessary for the purpose, proposing that the chimney should have an internal diameter at the top of 100 feet, and an external diameter at the bottom of 140 feet, and estimating its cost at about £40,000. The capacity of the chimney for conveying smoke gases, on the calculations of a velocity of 40 feet per second, would be in twelve hours 480,000 cubic yards. The gases from the combustion of two million tons of coal per annum represent 46,000,000 cubic yards per day. So that the calculations allow room for nine times as much gas from the sewers, which would be very ample.

Mr. Spence stated that the value of the sewage from Manchester and Salford, with the ammonia contained in the coal, would have a commercial value of £800,000 per annum; during this gaseous process the sewage would be throughly disinfected by the sulphurous acid gas contained in the smoke. The Corporation could easily try the plan at Kensington fields, and it would have been very advantageous in the erection in Nash Grove for purifying the sewer gas pouring out of the ventilators; by this means the sewage would be disinfected, and the manurial properties contained in the smoke deposited. This scheme would undoubtedly act very well, though the expense of remodeling our houses and sewers puts the adoption of it out of court for the present. But where new towns are being laid out, the adoption of the principle could easily be carried out, and as the central smoke stack would carry all deleterious vapors clear away, the houses could be made with flat roofs and laid out as flower gardens.

I could also propose the burning of fires in the streets over the ventilators; this would doubtless draw out all the bad gas, and the number of ventilators could be reduced, but this would interfere with the traffic, besides being an eyesore.

The placing of charcoal over the ventilators has an effect, but for a brief period only, as was proved at Southport during the visit of the British Association. The poor levels of the sewers there always cause a pressure of sewer gas when the tide is up, and walking down any part of the town the smell is anything but pleasant. The visit of such a learned body to Southport was an event of which capital could be made, and the Corporation, always zealous in forwarding the interest of the inhabitants, bethought them that if they could only get the sewer smells done away with during the meeting they would be enabled to get a testimonial as to the salubrity of the place and its freedom from noxious inhalations. Charcoal filters were applied for a few weeks, and the result was all that was required, but they were, I believe, done away with as soon as the object was attained.

With the exception of Mr. Spence's system, decomposition of sewage matter must and will take place, for even if Mr. Shone's system were generally adopted the sewage matter would require deodorizing prior to being placed upon the land. In nature's economy it was doubtless intended that refuse matter should return to the land to increase the productiveness, but so far, with only one or two exceptions, such as Aylesbury, Aldershot, etc., sewage farming has been a failure commercially. Not that the ratepayers would grumble at being taxed to cover the loss; but the enormous quantities to be treated, and the confession by those in authority that the money already spent on sewage schemes was of little value, will prevent for a long time the subject being grappled with. What we must look to in any case is the prevention of decomposition, and the application of antiseptics in our houses before the kitchen refuse and excreta from our water-closets pass into the sewers. By this means the enormous amount of sewage matter daily discharged into our rivers would be thoroughly disinfected, and no ill effects from sewer gas would be perceptible. In the case of the Thames, 160,000,000 gallons per day are discharged into it, and often in consequence of the lowness of the upland water there is from fourteen days' to thirty days' sewage washing backward and forward at the rise and fall of the tide, awaiting a freshet to carry it out to sea, in the mean time throwing off its vile gases continually.

If the Commissioners of Sewers were to see to the application of antiseptics prior to the matter passing into the sewers, the houses and streets of the metropolis would be pure, and the Thames, although often containing sewage matter in motion, would not throw off any objectionable or dangerous exhalation. When we know that at the outlet works on the Thames the Commissioners used during August 180 tons of chloride of lime per week, the effect being extremely beneficial as far as the river was concerned, although the matter had then undergone considerable decomposition, it is self-evident that if the antiseptic were applied before fermentation commenced a much less quantity would be necessary.

This being proved, the question will be, What are the most powerful antiseptics and disinfectors? The most effective and active are those which evaporate or throw off their essential gases, as chloride of lime and tar acid. The objection to chloride of lime is that it so quickly deteriorates and becomes worthless, and acts only, as Angus Smith says, "upon putrefaction that already exists," but tar acid acts upon the process, and prevents the tendency to putrefy. The action of the best known tar acid—carbolic—upon germ development has been so amply proved by the highest authorities that it is needless to discuss further upon its merits; but I would draw your attention to a rival preparation that undoubtedly will be much heard of in the future: it is made from a combination of tar acids, and has many points in its favor for which it will doubtless receive the preference.

THE PREPARATION OF COCAINE.

By A. CASTAING, Ph.G.

COCAINE is undoubtedly the great object of interest of the moment, and there is not a physician of progressive ideas who is not anxious to test the marvellous effects of the new anæsthetic. The drug trade, taken unawares by the sudden and sustained demand for cocaine of the various brands which are guarantees of genuineness, is unable to keep pace with it, and is therefore compelled to offer a substitute in many cases inferior to the article called for by the doctor's prescription. The natural consequence is that the anticipated effect is not produced, and the wished for and confidently expected local insensibility is not attained. The practitioner is disappointed at his first experiment, his professional pride receives a shock, and in his mind doubt takes the place of the enthusiasm he was at first inspired with. Yet it would be wrong to cast the blame upon cocaine, for the alkaloid, when real and chemically pure, does truly possess the power of producing local anæsthesia, not only on mucous membranes, but also on the whole surface of the epidermis, and, to a certain depth, beneath it.

Considering the difficulties attendant on obtaining the genuine article, we think we shall do well to make known a way, which repeated trials have shown us to be the most effectual, to extract the alkaloid from the *Erythroxylon Coca*. Having observed that cocaine is extremely susceptible of change under the influence of acids, we studied how to exhaust the coca leaves without using acidulated liquids, and discovered the following method, by which one grain of cocaine can be extracted from four hundred and eighty grains of leaves. To obtain this result, however, it is requisite that the coca leaves be of good quality—that is, gathered at the right time and place, properly dried (a leaf with brown spots on it, resulting from moisture, has lost all value)—and, above all, not injured by age or by exposure to the air and consequent evaporation.

MODUS OPERANDI.—On one part (by weight) of coca leaves pour eight parts of boiling water, and let them steep for half an hour in a closed vessel in a water bath. Pour the whole into a percolator, and, when all the liquid part is strained off, continue the exhaustion of the leaves by pouring on them eight parts of alcohol at 85°. Mix the two liquors and precipitate them by means of acetate of lead, draw off with a siphon, and then add sulphate of sodium to remove the salts of lead. Filter, and evaporate at a gentle heat until the liquid has attained the consistence of sirup. Treat the whole

with water to separate the resinous part, and then precipitate with carbonate of sodium. The precipitate is then to be exhausted by sulphuric ether, and the ethereal solution, after the ether is distilled, is exposed to the air until every trace of ether has completely disappeared. By this means is obtained a crystallized residue of a brownish yellow and of a disagreeable smell. This is impure cocaine.

The coloring matter is removed by washing once or twice with cold alcohol. The cocaine, thus purified, appears in the form of transparent prisms, without smell, bitter to the taste, soluble in seven hundred parts of cold water, more soluble in alcohol, and entirely soluble in ether. The solution has an alkaline reaction, and when applied to the tongue it imparts a bitter taste and a certain insensibility, followed by a slight sensation of cold, recalling the effect of ether spray upon the epidermis.

Heated to 208° F. the cocaine becomes liquid, and, under the influence of cold, it becomes a transparent mass, which gradually assumes a crystalline form. If it be exposed to a degree of heat higher than 208° F., cocaine changes its color, and decomposes. It is inflammable, and burns with a brilliant flame, leaving an ash behind it. It forms soluble salts with acids (its hydrochlorate is the best), and all these salts are more bitter than the alkaloid. It is a compound of carbon, hydrogen, nitrogen, and oxygen.

The medical profession is well acquainted with the effects of wines, extracts, and infusions of coca. I trust that what I have written above will show clearly how its action varies in accordance with the amount of cocaine contained by the leaves, and that in order to obtain the true therapeutic effects of coca, it is absolutely necessary that the cocaine be titrated at a fixed dose in all its preparations.—*N. Y. Med. Jour.*

RECENT DISCOVERIES AT CIVITA LAVINIA.

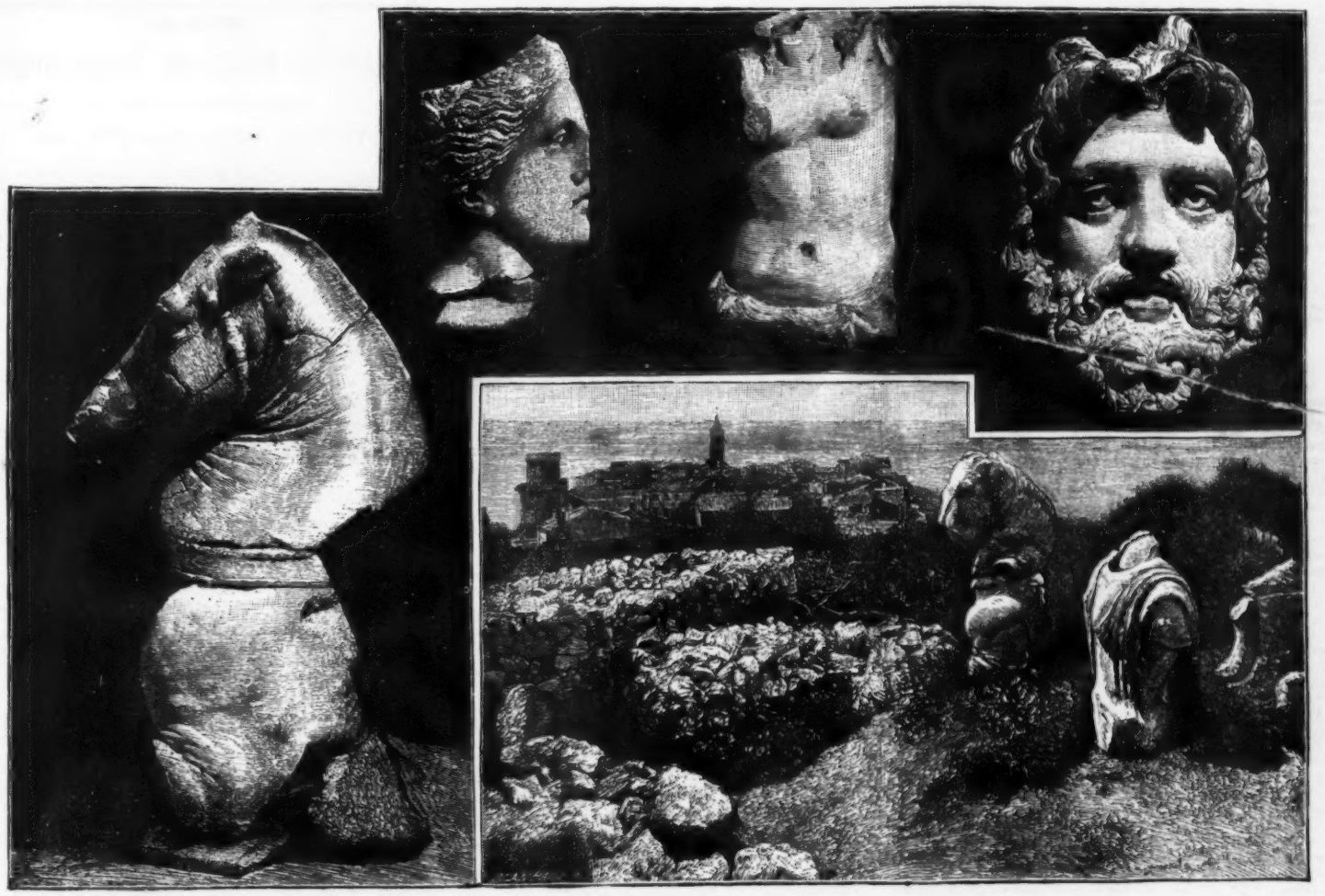
AT the annual meeting of the Archæological Institute at Newcastle, Mr. R. P. Pullan read a paper on some interesting discoveries, the result of excavations undertaken by him conjointly with Sir John Savile Lumley, H.B.M. Ambassador at Rome, in the spring of this year, at Civita Lavinia, the ancient Lanuvium.

Civita Lavinia is a walled town situated on a spur of the Alban Hills. Its fortifications are for the most part mediæval, and inclose only a portion of the ancient city. Lanuvium was celebrated for a temple of Juno Sospita. It was also the birthplace of Antoninus Pius and of Roscius. There are many remains of antiquity in and around the town. Among others, the *cella* of a temple, which Sir W. Gell supposed to be that of Juno. This, however, could not have been the case, as we know from ancient writers that the temple was surrounded by a grove, and the *cella* stands on the edge of a declivity, and close to a boundary wall and road of Etrusco-Latin times. Under the houses there are remains of a theater, where a fine statue of Claudius was discovered a few years ago. Mr. Pullan visited Civita Lavinia in 1879 with an eye to excavation, and then came to the conclusion that the temple of Juno Sospita had stood on a plateau about a quarter of a mile to the east of the present town. In the spring of the present year he mentioned his intention to excavate to Sir. J. S. Lumley, who generously offered to aid him with money and influence.

After the discovery of the wall of the *temenos* of the temple, excavations were made on a lower level, and the result of three months' excavation was that an oblong building, surrounded by arcades, or colonnades, was exhumed. Its dimensions were 113 ft. by 41 ft. In and around it several singular pieces of sculpture were dug up.

Three horses' heads in Parian marble, life-size, were found. Mr. Pullan considers these to be either original Greek work or the imitation of Greek work by Roman sculptors before the time of the Christian era. From the fact that subsequently the ear of a fourth horse and also the spoke of a chariot-wheel were discovered, he thinks that these were the horses of a quadriga, which stood on the summit of the building like that which was placed on the Mausoleum at Halikarnassos, in the disinterment of which he was engaged with Mr. Newton. The horses must have had bronze bits like those of the Mausoleum, as the holes in which they were fixed are still visible. The head of a female divinity—probably of one driving the chariot—was also found. The chests and portions of the legs, tails, etc., of the horses have also been brought to light. Sir John S. Lumley intends to continue the excavations during the winter; and should he be fortunate enough to recover the remainder of the group and the quadriga itself, the discovery will be one of the most remarkable of modern times. Six torsos of Roman warriors in cuirasses, togas, and girdles were dug up in the vicinity; but they seem not to belong to the quadriga group, as they are comparatively late in date and coarse in execution.

In the accompanying illustrations are shown the site of the diggings, with Civita Lavinia and the Campagna in the distance; one of the horses' heads—which, however, does not fit the chest on which it has been placed; the head of the female divinity; the body of Naiad found in the building, which seems to have been a nymphæum; and a head of Jupiter, found in the Villa of Caligula, near Civita, which is also in course of excavation by Sir John S. Lumley and Mr. R. P. Pullan.—*London Graphic.*



DISCOVERY OF ROMAN REMAINS AT CIVITA LAVINIA (THE ANCIENT LANUVIUM), ITALY.

ANCIENT BONE CAVE IN PENNSYLVANIA.

ONE of the most remarkable repositories of bones of our ancient fauna, in the Eastern United States, is known as Hartman's Cave, about five miles southwest from the Delaware Water Gap, and in the township of Stroud, Monroe County, Pa.

It has been intermittently opened and explored by Mr. T. Dunkin Paret, of Stroudsburg, during the past seven years, and numerous interesting implements of prehistoric man and bones of extinct species of animals have been exhumed; with these were also found the bones of animals not now inhabiting the vicinity, and also those of the present fauna. The bones and implements found were submitted to Dr. Leidy, of Philadelphia, for determination, and his remarks on the subject before the Academy of Natural Sciences of Philadelphia are published in the Proceedings for 1880.

The cave is along the axis of an anticlinal fold in the Lower Helderberg (Pre-Meridian) limestone, forming portions of the crest and the southeast flank of Godfrey's Ridge, which here attains an elevation of about 280 feet, and runs parallel with the range of the Blue Mountains; separated from it by the broad Cherry Valley. On the other (N. W.) side the crest is of Oriskany (Meridian) shales and sandstone, and the northwestern flank of Cauda-Galli grit (Post-Meridian), along which runs McMichael's Creek. The ridge is formed by a main anticlinal and a synclinal folding shaped like a letter N, near the cave. The eastern limb of the synclinal fold is very short, and the crest of the hill is the top of the anticlinal fold principally. At one point is what appears to be a transverse faulting across the hill of from thirty to forty feet; by this a perpendicular cliff is formed facing southward, and in it is exposed, forming a magnificent arch in the strata of the Lower Helderberg limestone, the top of the anticlinal and its axis, into which, from the bottom of the cliff, extends the cave in a north-northeasterly direction. From its entrance is obtained a fine view down Cherry Valley, and along the base of the Blue Mountains.

When discovered, the entrance to the cave was nearly covered by the debris sloping up the face of the cliff, leaving only a small passageway, into which many adventurous persons had crawled from time to time.

The original cave was filled nearly to its top, and exploration was commenced by cutting a trench through the debris in front. The work had not progressed far before bones were found, and soon after implements of man's handicraft, the finds becoming more frequent and greater when the entrance to the cave was reached, and for fifty feet into it. Beyond this, for the two hundred feet further of exploration, nothing more was found. The passageway made was about six feet in height; a pit was also sunk eight feet deeper, at one point, but without finding the bottom rock, and the depth and length of the cave are unknown. It was filled to within three or four feet of the roof with a fine, unctuous clay, rather irregularly stratified, but very pure and homogeneous in quality. Upon this lies the stratum in which were found the bones and implements; its thickness is irregular, but it about half fills the remaining space. It is composed in part of stalagmite and of a gray friable heterogeneous mass of animal and vegetal debris, dust, sand, and calciferous matter, often cemented into masses by the infiltration of carbonate of lime in solution; above this there is considerable fine stalactical formation hanging from the limestone roof.

The implements found were considered very interesting by Dr. Leidy. The only stone implement was a large celt skillfully wrought from a hard brown slate. This was found in the layer of bone-earth some distance in the cave; all the other implements were of bone. A number of awls, some finely polished, were obtained from the debris at the entrance, and also in the cave signs of gnawing by small carnivores were prominent on some of them; but all were in a tolerably good state of preservation. An implement made from the prong of an antler, with a barb cut on one side, was found in the entrance of the cave, and "appears to have been used as a needle in mending nets." Near by was found a small implement much mutilated by gnawing; seems to have been similar to an ordinary needle, the eye or perforation part of which, however, had been gnawed away, the remains resembling a crochet needle. Another implement found was a bone fish-hook.

Evidences of man having inhabited the entrance to the cave were not numerous. Fragments of charcoal are quite abundant, and a large portion of the animal remains were in fragments and splinters, often of large bones, and generally bearing tooth-marks of the rodents or small carnivores which have gnawed them. Others appear to have been gnawed by larger carnivores; and others, as Dr. Leidy suggests, seem as if

they could only have been splintered by human power for the purpose of extracting the marrow. Some pieces are somewhat charred, especially a portion of the jaw of a bison holding a molar tooth, which exhibits very apparent evidence of having been subjected to heat, and probably formed a remnant of some human feast. A cone shell (*Cornus tornatus*), bored through its axis for use as a bead, was discovered by Dr. Leidy, and he states that it is a member of the fauna of the western coast of Central America, and would indicate an extended intercourse among the natives of ancient times.

The bones in the collection sent to Dr. Leidy amounted in all to about a half bushel. He reported them as the remains of species mostly modern, some not now found in the State, and others extinct, and how far they were contemporaneous was uncertain, but that they seemed to have accumulated in the cave during a long succession of years following the glacial period.

The extinct species were, the Ohio beaver (*Castoroides ohioensis*), of which an incisor and six molars were found.

A part of an upper and lower jaw, with teeth, of a young peccary (*Dicotyles nasutus*) was found in the cave, about fifty feet from the entrance. "This is a species previously known only from a single piece of an upper jaw from Indiana. ("Extinct Mammalia of North America," 385, pl. xviii., Figs. 1 and 2; J. *Academy Nat. Science* vii. 1869.)

The remains of animals of species not now embraced in the fauna of the State were bones and teeth of the caribou, or woodland reindeer, *Rangifer caribou;* a fragment of the lower jaw, with the last molar, of the bison, B. *americanus*; many lower jaw halves and other bones of the woodrat, *Neotoma floridana*. Most of these are of comparatively large size, and similar to remains referred by Dr. Baird to a supposed extinct species with the name *Neotoma magister*. (U. S. P. R. R. Expedition and Surveys, Zoology, viii., 1857, 498.)"

The remains of other animals were of the deer, *Cervus Virginianus;* The elk, *Cervus canadensis;* the wolf, *Canis lupus;* the lynx, *Felis canadensis;* the gray fox, *Vulpes Virginianus;* the raccoon, *Procyon lotor;* the skunk, *Mephitis mephitica;* beaver, *Castor fiber;* the weasel, *Putorius erminius;* porcupine, *Erthizon dorsatus;* woodchuck, *Arctomys monax;* the muskrat, *Fiber zibethicus;* the gray rabbit, *Lepus sylvaticus;* the ground squirrel, *Tamias striatus;* the mole, *Scalops aquaticus;* the meadow mouse, *Arvicola riparius*; the whitefooted mouse, *Hesperomys leucopus*; the dusky bat, *Vespertilis fuscus;* the little brown bat, *V. subulatus;* and the complete isolated first and second molars of a new-born or fœtal horse.

Numerous remains of birds were found, mostly, however, of the wild turkey, *Meleagris gallopavo*.

The remains of reptilia consisted of numerous [illegible] of several species of snakes, and of the [illegible] *Cistudo clausa*; the [illegible] *Chelydra serpentina;* and other[illegible]

Helices were [illegible] plentifully, and included *H. arbustorum*, *H. labyrinthica*, *H. inflata*, and *H. tridentata*, and a valve [illegible] *Campeloma*.

The vegetal remains included, besides the fragments of [illegible] before mentioned, seeds of the dogwood, *Cornus floridia;* the pig nut, *Carya porcina;* and walnut, *Jugulans nigra*.

During the examination, the writer found bones of a number of the above detailed species. Among them were numerous vetebræ, the remains of four black snakes (*Bascanion constrictor*), and near by many ribs, some quadrate bones, and other portions of the skull of the same species, portions of the shell of the box tortoise, femurs, humeri, ribs, vertebræ, and left halves of inferior maxillaries, with teeth, of the skunk. A portion of a humerus, inferior maxillaries with teeth, of muskrats, incisors of the wolf, helices of *H. Tridentata*, a gnawed walnut, and other bones and fragments of unrecognized species. These were all found either in the bone-earth in the cave or in the undisturbed debris in front of its entrance.

The formation of the cave seems to have been due to simple means, and as Dr. Leidy suggests, probably excavated by the action of a glacial stream from melting snow and ice, making and enlarging a passageway through the limestone, along the fissure at the axis of the fold; and at another or perhaps the same time depositing the clay, into the passageway formed vegetable matter and dust were blown, and at the same time small animals who made this their den dragged into it the bones of larger animals to gnaw at their leisure, and left also their own remains; while man, using the entrance as a protection during the storms, or perhaps as a temporary dwelling, from its fine commanding outlook down the valley, have left the remains of their feasts, the broken or charred bones of animals, and a few of their own implements.

Whether the cave has been formed from the top downward by clear or rapidly running water, and the clay deposited subsequently, as seems probable, or if excavated from the bottom, and the clay deposited contemporaneously, is of considerable interest. In the former case there may have been a long interval in which the cave was dry, and perhaps inhabited by man or animals; and if this were so, and subsequent currents flowing through the cave were not too powerful, a layer would exist under, similar to that over, the clay, and probably containing remains or implements of great interest. If the exploration is continued, this will undoubtedly be determined, and may yield results of the greatest value both in giving us information relative to the customs of the early inhabitants of our country, and remains of its interesting early fauna.

N. H. DARTON.

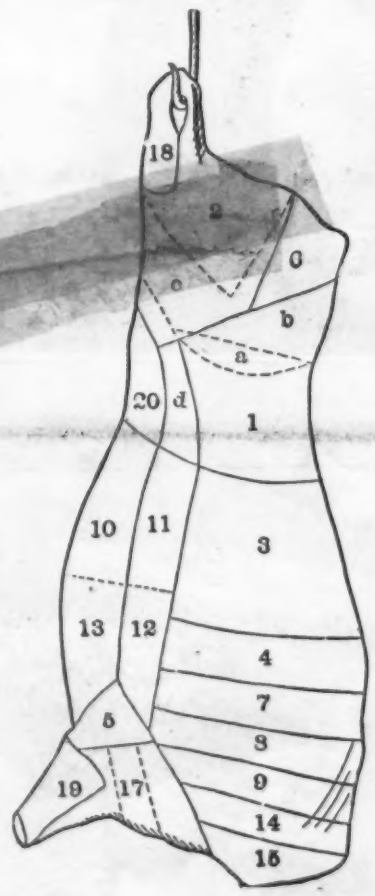
ACTION OF WATER ON DOUBLE SALTS.—On this subject, F. M. Raoult lately came to the following conclusion before the French Academy of Science: According as the lowering of the freezing point of a double salt, dissolved in water, is equal or inferior to the sum of the partial lowering of the freezing points of the simple salts composing it, it may be affirmed that the double salt is or is not entirely separated into its two generators.

THE ANTISEPTIC PROPERTIES OF CARBON DISULPHIDE.—*Chiandi Bey.*—Carbon disulphide is soluble in water to the extent of 0·50 grm. per liter. The solution arrests all fermentations and kills microbia. During twenty years' experience the author has never known a case of paralysis among the workmen constantly exposed to the fumes.—*Comptes Rendus.*

CUTTING UP BEEF.

THE object of our cut is to show how a side of beef is cut in the three principal cities, New York, Chicago, and Philadelphia; and second, to settle the vexed question of what is a porterhouse, sirloin, and rump steak. By referring to the cut the solid lines show the Chicago and New York method of cutting, and the dotted lines show the variation made in the Philadelphia style. For example: a, b, c, and 6 being their rump; 2 the round, with veiny pieces or knuckle left on the rump; the veiny piece is cut either on the round or rump at pleasure, or as may be to the advantage of the dealer or choice of buyer; a is the pin bone, sold for roasting. Then follow the rump steaks, parallel with the straight dotted line; the sirloin and sirloin steak is No. 1, below the curved dotted line.

It will be seen from this that, considering the different style of cutting, a Chicago cutter, strictly speaking, has no rump steak. The nearest equivalent to a Philadelphia sirloin is the Chicago porterhouse; the back cut sirloin is the same cut, it being in Chicago and New York strictly the porterhouse, and in Philadelphia the sirloin steak. With the above explanation we think it will be plain that it is not so much a different nomenclature as a different method of cutting that makes the confusion and difference of opinion as to what is a rump, sirloin, or porterhouse steak. As to which is the most profitable way to cut we will leave for another article, and finish this by giving the general name of cuts in the three cities, keeping in mind that the solid lines represent the Chicago, New York, and nearly the English style of cutting, while the dotted lines in the hind quarter show the Quaker and partly German method.



The first cut made in a side of beef is the line below 20, cutting down the fore quarter, thus cutting close to and leaving all the ribs (13) in the fore; sometimes one and even two are cut to the hind quarter so as to give more loin, but this is what we call a "shoemaker's cut," and is not recognized in the trade; on the contrary, to make the loin and rib cut square a portion of the former is left on the latter.

The second cut is along the line between b and 6, which takes off the loin (Chicago), but this is varied somewhat by cutting up toward C, keeping close to the bone; again the round is cut off first along the solid line between 2 and 6, and c and a, keeping more toward c. The leg, 18, is cut off at any time, as the flank may be. In cutting the fore quarter, the first cut is along the line to right of 5, through shoulder joint down to the plate and brisket, 5 being raised up and cut or sliced as it were from the plate and brisket. (This cannot be shown in the engraving.) Next, the knife is run along the line to right of 11 and 12, over top of ribs, which of course are sawed to point left of 15, thus leaving the back or rack of beef; 10 and 13 is separated from 11 and 12, leaving plate and brisket. The rack is cut at pleasure on any of the cross lines.

In this article we have thought it well to discard a number of nearly obsolete local terms, such as rattle ran, etc.

The Chicago method of cutting is becoming more and more popular as its advantages to the dealer become known; and as the same style is in vogue in New York, the time is not far distant when all will cut alike, as some one way must be the best, and we believe the packing-houses and what the butchers of Chicago know how to cut beef to, must the best advantage for the trade.

The drawing is our own, and if not an artistic one, it is more the fault of a hand better accustomed to cleaver and saw than to pencil and pen.

EXPLANATION OF FIGURES IN THE CUT.

No.	Chicago Cut.	Philadelphia Cut.	New York Cut.
1, a, b.	Long Loin.		Loin.
1.	Short Loin.	Loin.	Short Loin.
2.	Round.	Round.	Round.
2, c.	Full Round.	Whole Round.	Full Round.
3.	(7) Rib.	(6) Rib.	(7) Rib.
4.	First Chuck.	First Chuck.	First Chuck Rib.
5.	Shoulder Clod.	Bowler Piece.	Cross Rib, part.
6.	Rump.	Tail end of Rump.	Rump.
7.	Second Chuck.	Second Chuck.	Second Chuck.
8.	Third Chuck.	Third Chuck.	Third Chuck.
9.	Fourth Chuck.	Fourth Chuck.	Fourth Chuck.
10.	Thin, or best end brisket.	Thin end Brisket.	Navel Piece.
11.	Thin, or best end Plate.	Thin end Plate.	Plate Piece.
12.	Thick, or butt end Plate.	Same.	Cross Ribs, part.
13.	Thick or butt end Brisket.	Same.	Brisket Piece.
14.	Neck Piece, or Chuck.	Neck Cut.	Neck Cut.
15.	Neck Cut.	Neck.	Neck.
17.	Shoulder.	Shoulder.	Clod.
18.	Leg of Beef.	Same.	Same.
19.	Shin.	Same.	Same.
20.	Flank.	Same.	Same.
a.	Cut in Steaks.	Pin Bone.	Hip Sirloin Steak
a, b, c, 6.	(Not Cut.)	Rump of Beef.	(Not Cut.)
c.	Part of Round.	Veiny part of Rump.	Part of Round.
b.	Sirloin Steak.	(Not Cut.)	Sirloin Steak.
d.	Top of Sirloin.	Top of Sirloin.	Thick Flank.

At 17 is shown middle cut of shoulder with the bone in, though the bone is often removed and the clod cut to suit.—*American Marketman.*

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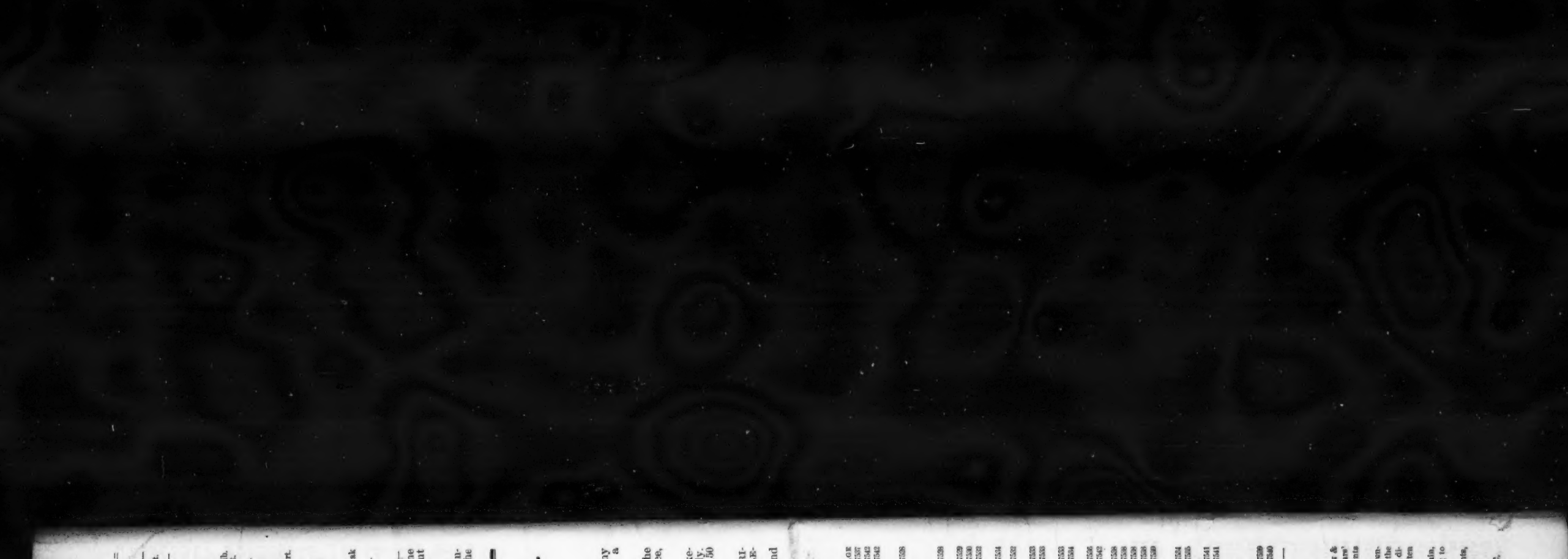
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